# SCHOOL SCIENCE

Vol. XXVIII No. 1 MARCH 1990

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

## FORM IV

*(See Rule 8)*

| | | |
|---|---|---|
| 1. | Place of Publication | National Council of Educational Research and Training (NCERT), Sri Aurobindo Marg, New Delhi 110 016 |
| 2. | Periodicity of Publication | Quarterly |
| 3. | Printer's Name<br>(Whether citizen of India?)<br>(If foreigner, state the country of origin)<br>Address | Supreme Offset Press<br>Yes<br>Not applicable<br>K-5 Malviya Nagar, New Delhi 110 017 |
| 4. | Publisher's Name<br>(Whether citizen of India?)<br>(If foreigner, state the country of origin)<br>Address | O.P. Kelkar, IAS<br>Yes<br>Not applicable<br>Secretary, NCERT, Sri Aurobindo Marg, New Delhi 110 016 |
| 5. | Editor's Name<br>(Whether citizen of India?)<br>(If foreigner, state the country of origin)<br>Address | Prof B. Ganguly<br>Yes<br>Not applicable<br>Head, Department of Education in Science and Mathematics, NCERT, Sri Aurobindo Marg, New Delhi 110 016 |
| 6. | Names and addresses of the individuals who own the newspaper and partners or share holders holding more than one per cent of the total capital | National Council of Educational Research and Training, New Delhi. (An autonomous Body of Government of India in the Human Resource Development Ministry) |

I, O.P. Kelkar, hereby declare that the particulars given above are true to the best of my knowledge and belief.

O.P. Kelkar
*Publisher*

Published at the Journals Cell by the Secretary, National Council of Educational Research and Training, Sri Aurobindo Marg, New Delhi 110 016, laser typeset at Scribe Consultants, B4/30 Safdarjung Enclave, New Delhi 110 029 and printed at Supreme Offset Press, K-5 Malviya Nagar, New Delhi 110 017.

A QUARTERLY JOURNAL
OF SCIENCE EDUCATION

Vol. XXVIII No. 1
March 1990

# SCHOOL SCIENCE

## CONTENTS

| | | |
|---|---|---|
| Cold Fusion: the Hot Topic in Chemistry | 1 | M. CHANDRA |
| A Safe and Energy Saving Lid for Heating Water by an Immersion Heater | 6 | SHRUTI BODH AGARWAL |
| The Mangrove Otter of Sunderbans | 9 | P. SANYAL |
| Measuring Reflection Factor of a Flat Surface | 12 | VED RATNA |
| Case Studies of Products, Processes and Systems as Science Projects at School Level | 17 | LALIT KISHORE |
| On Process-based Science Instruction | 19 | A.C. PACHAURY |
| Puppets versus Drugs | 24 | EDITH MASSUN |
| Difficulties in Implementing Creative Physics Teaching Methods | 28 | A.B. SAXENA |
| Divisibility Test by 7, 11 and 13 | | |
| Science News | | |
| Book Review | | |

## TO OUR CONTRIBUTORS

*School Science* invites articles from teachers, acquainting students with the recent developments in science and science methodology. The articles should be addressed to Executive Editor, Department of Education in Science and Mathematics, NCERT, Sri Aurobindo Marg, New Delhi 110 016.

# Cold Fusion: the Hot Topic in Chemistry

M CHANDRA
**Professor**
**Department of Education in Science and Mathematics**
**NCERT, New Delhi 110 016**

---

*Cold fusion, if made practicable, could make a world of difference In addition to making light bulbs shine, appliances work and factories run, it could be used for processes now best done by oil and coal It could even replace gasoline*

---

Due to the fast depletion of fossil fuel, active interest has recently been evinced in harnessing alternative sources of energy One possible new method for this is to electrochemically initiate a nuclear fusion of deuterium, which can liberate a large amount of energy (1)

Nuclear reactors of the present day generate energy with the use of the type of reaction called fission, wherein nuclei of elements with high atomic weights such as Uranium, Plutonium are bombarded with particles of nuclear size such as neutrons. This makes these large nuclei split up into smaller nuclei, and this process releases tremendous amounts of energy. In contrast, fusion is a nuclear reaction, in which nuclei of elements having very small atomic weight fuse together, under certain conditions, to form nuclei with a larger number of nucleons. This reaction also releases large amounts of energy, as in the sun, where hydrogen nuclei fuse together to form helium nuclei releasing heat, light and UV radiations in the process Till recently, scientists believed fusion could take place only at very high temperatures of the order of 100 million degrees celsius and tremendous pressure, as happens in the core of the sun. The high temperature and pressure, it is believed, help overcome nuclear forces that exist between nucleons in the nucleus of an atom and fuse them to form a new nucleus The only successful practical application of a fusion reaction has been the so called hydrogen or thermonuclear bomb, where a fission reaction (of the so called atomic bomb—not a very descriptive name) is used to provide the very high energy needed to initiate fusion.

On 23rd March 1989, B. Stanley Pons of the University of Utah and Martin Fleischmann of the University of Southampton in England, announced to the press and claimed later through their publication in the *Journal of Electroanal Chem Interfacial Electrochem*, 261 (1989), 301-308, that they had created nuclear fusion in a bottle using a little water, wire and electricity.

For their experiment, Fleischmann and Pons started with salty heavy water in which deuterium atom replaces H atom of $H_2O$. In this they suspended a rod of Palladium (Pd) wrapped around with Platinum (Pt) coil, and sent electricity through the metals. The chemists reported neutrons from the Pd rod, and 3 to 8 times more heat energy than what was put in the electrodes Their explanation was that when current was passed between the electrodes, deuterium was adsorbed into the Pd electrode and there, the scientists said, it underwent fusion, producing heat as well as small number of neutrons.

Around the same time, Steven Jones and his coworkers at the Brigham Young University (BYU), also in Utah, who had been working for some years on much catalysed fusion, separately published in the 27th April 1989 issue of *Nature* results of similar experiments.

Jones' apparatus consisted of a glass beaker with an anode of gold foil and a cathode made of Pd foil on rough Titanium (Ti) or Pd chunk, driving deuterium into the metal with a voltage of 2-35 volt and cell current of 10-500 mA. The electrolyte was heavy water ($D_2O$ in a solution of pH 3) containing salts of various metals Using a sophisticated neutron spectrometer developed at BYU over the past few years, Jones and his coworkers measured the energies of neutrons emitted from the cells. Fusion of deuterium within the metal lattice was given as the possible explanation for their results (2).

The main difference between the two papers lay in the magnitude of the reported effects and the way in which they were measured. The BYU group got a dozen neutrons/hour from their cells—while the Utah team measured heat instead of neutrons. The two papers also differed greatly in their implications The amount of heat observed by the Utah team has obvious possible application. The BYU paper on the other hand devoted much to geophysical considerations.

These events have been the starting point of the race for 'cold fusion'—so called because it operates at room temperature—and has provoked a lot of new thoughts about how to induce fusion under conditions previously thought impossible. Excitement has not only been in the scientific community, but also among the lay public. So much so, that the price of Pd—the metal that has played an important role in the process—has been reported to have gone up. Not only instant substantial increases in the scientific grants in the field of 'cold fusion' research had been announced, but international conferences were held at close intervals specifically to discuss this phenomenon—one such conference, the one held in Dallas, Texas had to be organised in a 10,000 seat basketball arena—packed to near capacity.

Following the announcement of Fleischmann and Pons, scientists in other countries of the world, viz. USSR (Moscow State University, Byelorussian State University), Italy (National Agency for Nuclear and Alternative Energy); Czechoslovakia (Comenius University), Hungary (Lajor Kossuth University); Brazil (University of Sao Paulo and Institute of Space Research), UK (University of Birmingham, the Rutherford Appleton Laboratory, the UK Atomic Energy Authority) have been pursuing work in this field (3).

### The Indian Scene

The Indian scientists are not lagging behind either. The scientists at the Indira Gandhi Centre for Atomic Research at Kalpakkam, the Bhabha Atomic Research Centre (BARC), the Tata Institute of Fundamental Research (TIFR), have reported positive results in their efforts.

At Kalpakkam, for work in 'cold fusion' activities, Ti mesh was used as cathode in the initial experiments, for later experiments Pd electrode was cast from the powder form. A typical electrolysis cell consisted of a Pt mesh anode in the form of a cylinder with Pd cathode in the centre. In some experiments cylindrically shaped Ti mesh cathode surrounded by Pt anode was used. Electrodes were immersed in 70 ml heavy water made conducting by adding LiOH Cathode temperature was measured by a thermocouple and the solution temperature was measured by a thermometer A well type neutron detector was used The temperature rise at cathode in $D_2O$ electrolysis, as reported by the scientists was seen to be roughly twice that in $H_2O$ electrolysis. This factor was reported to vary with many parameters, viz. size, shape, condition of the cathode The net heat evolved, however, was reported to be in excess of the value estimated by assuming that each neutron emitted represents one fusion event (4).

At TIFR, experiments were conducted using Ti electrode as the cathode, Pt electrode as the anode and NaCl as the electrolyte. Analysis of the electrical power that was fed into the electrochemical reaction showed that electrolysis of $D_2O$ in fact turned out to be happening of free, and that there was a substantial power gain during the experiment. However, the scientists reported that further experiments would have to be carried out for confirming nuclear fusion during $D_2O$ electrolysis (5).

At the Variable Cyclotron Centre of BARC, scientists have observed bursts of neutrons in the electrolysis of heavy water using both Pd and Ti as cathode. The bursts are several times above the background, last for about five minutes and are aperiodic. For their experiments, Pt was used as the anode in all the cases. A small quantity of sodium chloride was added during electrolysis Water in the cell was continuously stirred using a small magnetic stirrer, ensuring uniform distribution of heat The scientists are planning for more elaborate experiments to investigate the parameters governing the cross-section of fusion in these processes (6) However, in recent experiments, the BARC scientists have characterised 'cold fusion' reaction to be essentially 'aneutronic', where a large amount of tritium is produced (7).

## Possible Mechanism of 'Cold Fusion'

The "Utah pair" attributed cold fusion to some "unknown nuclear process" Ordinarily when two deuterium nuclei fuse, they produce a nucleus of $^4$He (Helium-4, 2 protons and 2 neutrons). It survives only for a split second, before breaking into small particles. One way to explain the results of Fleischmann and Pons would be if the $^4$He does not shatter Scientists suggest in fact that the $^4$He stays together and transfers its energy to the Pd lattice. This would produce heat but produce no neutrons. This energy can agitate more deuterium nuclei and make them fuse The chain breaks, if a $^4$He does splinter, sometimes spinning into a neutron. Those may be the rare neutrons that some groups report.

The possible fusion reaction between 2 deuterium could be:

$$^2H + ^2H \rightarrow ^3He + ^1H$$
$$^2H + ^2H \rightarrow ^3He + ^1n$$
$$^2H + ^2H \rightarrow ^4He + \gamma$$

Of these, the 3rd process is considered to be of low probability.

One can however think of another nuclear process

$$^2H + ^2H + \text{Pd lattice} \rightarrow ^4He + (\text{Pd-lattice})^*,$$

where * represents the higher energy state Experiments for detecting $^4$He are under planning (8).

## Muon Catalysed 'Cold Fusion'

Scientists have shown that tiny particles called muons from cosmic rays can cause a different kind of 'cold fusion'. In muon catalysed 'cold fusion' the tiny particles bring together nuclei of deuterium or tritium which otherwise should stay well apart Muons shot at the nuclei bump the electrons away and replace them in orbit. But since muons are 207 times heavier than electrons, they orbit the nuclei more closely, in effect shrinking the atom This lets the nuclei get close enough to fuse, releasing energy and in the process usually frees the muon, which then finds another nucleus. The process goes on till the muon decays in about 2 millionth of a second, or until it sticks to one of the particles ejected by the fusion. So far scientists have been able to make muons into causing about 200 fusions before they vanish But since it takes energy to create muons in the laboratory, to make muon assisted fusion produce as much energy as it consumes, each muon would however have to cause 500 to 1000 fusions (9).

But Fleischmann and Pons got more than twice the number of fusions than would seem from muons alone. It may be that the Pd lattice is the help muons need. By squeezing deuterium into the Pd metal lattice and hitting them with muons, it may be possible to make muons cause enough fusion to be practicable.

### Boson Screening Theory

Scientists of University of California at Berkeley have proposed a 'boson screening theory' to explain how deuterons (nuclei) inside a Pd electrode can get close enough together to fuse. Deuterons are bosons, a class of particles that interact with one another in a special way. In particular, the scientists suggest that the deuterons assume their lowest possible energy level, such that the energy of repulsion between the deuterons is mostly screened out so that the particles can get on top of each other despite the repulsion (10).

### Controversies around 'Cold Fusion' Activities

Due to claims and counter claims of success of cold fusion experiments, much excitement, though often premature, has taken place in this field. However, replicability of the various experiments has been doubted. For whatever reason, both the neutron emission and the excess heat are difficult to pin down, and even the laboratories that have seen the effects, cannot repeat them in every test sample.

Further, most nuclear physicists are still extremely sceptical about the reality of 'cold fusion', specially because of the sketchy data. They claim that fusing two deuterium atoms generally requires a great deal of energy to overcome the mutual repulsion between their nuclei, and it is difficult to see where this energy is coming from. Further, though neutrons have been detected in some experiments, the number is one billionth of what would be expected, given all the heat that Fleischmann and Pons claim to have measured.

Also, theorists are yet to describe how fusion can be produced in Pd electrodes at room temperature—when fusion of 2 deuterium atoms normally requires tremendous temperature and pressure. Explanation is yet to come also for the fact why, heat measure from the "Utah cell" is a billion times of what is expected by the number of neutrons detected. Finally, even if the process involved is indeed fusion, and not some unknown chemical reaction, the scientists still have to specify, what type of fusion reaction could be producing so few neutrons.

### Prospects and Problems of 'Cold Fusion'

Nuclear fusion being a 'clean' process, 'cold fusion' brings forth new promises. It would neither produce gases that cause acid rain, nor will it contribute to the 'greenhouse effect'. Not only is nuclear fusion safer than conventional atomic power plants, but 'cold fusion' uses cheap and virtually inexhaustible fuel. If developed properly, 'cold fusion' can indeed produce all the energy needed, specially for the oil importing countries. India, being one of the few countries producing heavy water in commercial quantities, may therefore have an advantage, if 'cold fusion' becomes a practical proposition.

However, 'cold fusion' may not yield enough heat to drive a turbine, the conventional way of generating electricity. Also Pd used extensively now in 'cold fusion' activities shows sharp decline in deuterium adsorption capacities at temperatures above room temperature. Pd is expensive and rare, although perhaps some other metal such as Ti might work. Further, it may be difficult, or impossible, to convert the 'cold fusion' apparatus from a table top model to a massive commercial scale.

## Concluding Remarks

But in spite of all this, if 'cold fusion' claims are validated, it would be an exceptional discovery in mankind's search for cheap, safe and plentiful source of energy. Furthermore, this claim has come at a time when for various reasons nuclear energy is particularly under attack. Cold fusion, if made practicable, could make a world of difference. In addition to making light bulbs shine, appliances work and factories run, it could be used for processes now best done by oil and coal. It could even replace gasoline.

However, even if the claims of 'cold fusion' should stand the test of time, as scientists put it, there may not be a chance of expecting applications of 'cold fusion' for another 10-25 years to come. However, to quote John Maddox, editor of *Nature* in this context, "Fleischmann and Pons have done at least one great service for the common cause. They have kindled public curiosity in science, to a degree unknown since the Apollo landing on the moon".

## References

1. Santhanam, K.V.S. et al. "Electrochemically Initiated Cold Fusion of Deuterium", *I.J.T.*, 27 (1989), 175-177.
2. Jones, S. et al. *Nature*, 338 (1989), 737-740.
3. *Newsweek*, May 8 (1989), 44.
4. Mathews, C.K. et al. "On the Possibility of Nuclear Fusion by the Electrolysis of Heavy Water", *I.J.T.*, 27 (1989), 229-31.
5. Same as in (1).
6. Sinha, B. et al. "Observation of Neutron Bursts in Electrolysis of Heavy Water", *I.J.T.*, 27 (1989), 275-277.
7. *Times of India*, Aug 14 (1989).
8. Same as in (4).
9. "Exotic Particles Adorn the Path of Cold Fusion", *New Scientist*, 16 59 (1989), 18-19.
10. Pool, R. "Fusion Theories, Pros and Cons", *Science*, 244 (1989), 285.

All recent issues till mid-July 1989 of *Nature*, *New Scientist* and *Science* have been consulted

# A Safe and Energy Saving Lid for Heating Water by an Immersion Heater

SHRUTI BODH AGARWAL
**64-A, Kamla Nagar**
**Delhi 110 007**

*In addition to safety, the device provides much economy (up to 50%) in electricity consumption as compared to heating water in an open bucket In case the immersion heater is leaking and the bucket becomes live, this device provides a safe warning too*

## Introduction

The author suggested the basic idea of this invention in 1978 as a student of Class X He observed his father, in grief stricken moods whenever talking about a film which he was producing in 1974. In that film a physics teacher of a school in Delhi was playing the lead role. She was accidentally killed by electrocution, as she tried to see how hot was the bath water, which was being heated by an immersion heater.

The author suggested why not check the degree of hotness of the water from outside the bucket, through a thin layer of an electrically non-conducting material. First prototype of this device was made by the author in 1983 jointly with his younger brother. It was presented for the CBSE Class XII examination project work. In addition to safety, the device provides much economy (up to 50%) in electricity consumption as compared to heating water in an open bucket. In case the immersion heater is leaking and the bucket becomes live, this device provides a safe warning too

## Construction and Working

This device is essentially a lid which covers the metallic bucket in which water is being heated by the immersion heater. Figure 1 shows a top view of the lid placed on the bucket. Figure 2 shows a sectional view of the lid placed on the bucket in which water is being heated

On the lid is built a capacitor with a thin layer of a dielectric material in which there is a balance of high dielectric constant, high coefficient of thermal conductivity and capacity to stick two metal sheets. The lid has to be made of a material with large thermal diffusivity, e.g. aluminium On the layer of dielectric is stuck a circular sheet of brass so as to make a capacitor between the two metal sheets. The lid is covered with foam or any other insulator of heat, except for the space occupied by the capacitor. The brass disc of the capacitor is maintained shining with the help of a cleaning agent (like Brasso).

When water in the bucket is heated by the immersion heater, the lid prevents water vapour from escaping. Thus much electric energy is saved The water vapour heat up the lid giving it approximately same temperature as that of water. Loss of heat from upper surface of lid is prevented by the foam. Thus there is only a little loss of heat from the sides of the bucket. In some

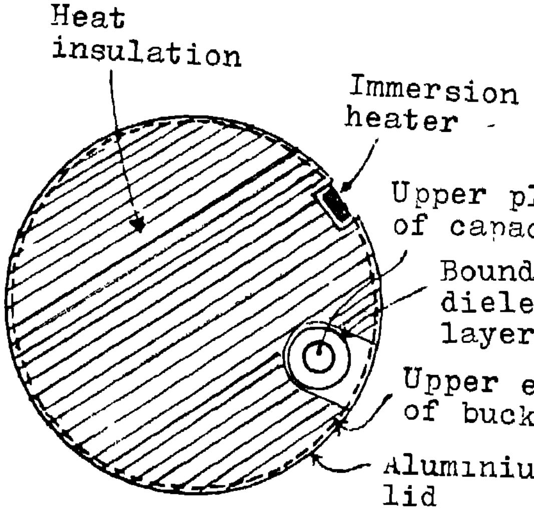


Fig.1

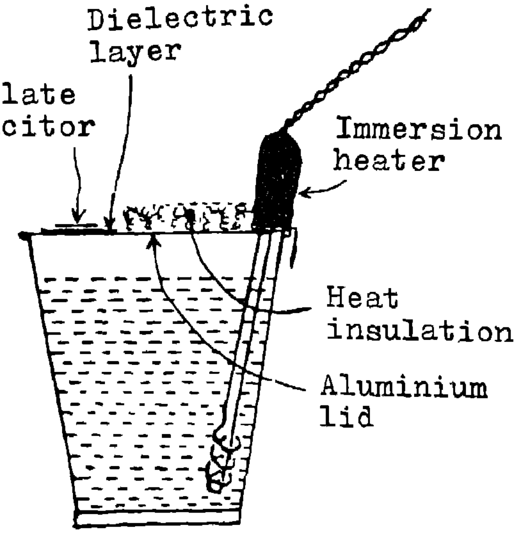


Fig. 2

situations the consumption of electricity with the lid may be almost half of that without the lid for boiling the water.

From the lid, heat is conducted through the dielectric to the brass disc. Due to shining surface of brass, and it being surrounded by about 3 to 5 cm high insulator walls all round, loss of heat from this surface is minimal. Thus the brass disc attains approximately the same temperature as the lid. In an experimental trial it was found that the temperature of the brass disc was only 2° to 3°C less than that of water, when the water approached its boiling point At temperatures suitable for bath water, however, this difference of temperature is quite negligible.

Whenever one wants to check up how hot the water is, one is to touch the brass disc for a few seconds, and feel how hot it is. This process is identical to feeling the water by dipping one's finger in water. Of course there is a little difference. Water makes contact with large area of your finger. Due to its intimate contact and large heat capacity water makes skin temperature equal to itself in a fraction of a second and you instantaneously feel the degree of hotness of water. In case of brass disc, your skin attains temperature of brass disc in 2 or 3 secon

## Safety Considerations in Comparison to Traditional Way of Using the Immersion Heater

Traditionally we heat water by immersing the heater in water. We check up how hot the water is by touching the surface of water. If the water is live due to the heater being leaky, its contact with finger passes a large current through our body, which can cause instantaneous death. But if one touches the capacitor plate of this lid, a weak safe current passes which causes a mild sensation. Thus it informs us that the heater is leaking. If by error we happen to touch the dry metal surface of the lid (in spite of it being covered by foam), the rude electric shock that we get is far milder than that we would get by touching water surface, and it does not cause serious physical damage.

In using the immersion heater in the traditional manner, it is a convenient precaution that we should switch off the current when we want to check up how hot water is. But in practice, we happen to neglect this precaution quite often, particularly if we are in a sitting position and the switch is high up, beyond the reach of our hand. Moreover, this precaution prevents us from knowing safely if the immersion heater is leaking

It is important here to mention that the foam and upper surface of lid have to be kept dry so that the brass disc is well insulated from the bucket. Normally it tends to keep dry as it warms up along with rise in temperature of water, unless we pour water on it. A good procedure for this purpose is to store the lid on a peg in the wall where water droplets normally do not reach. It has to be put on the bucket whenever it is to be used.

## Additional Applications

The basic device of this lid is the capacitor. It can also be built-in on the water boiler (not the geyser in which current gets switched off by a thermostat when the temperature of water rises to a preset value) which is far cheaper than a geyser of similar capacity and is thus quite popular. Such a water heater involves the same risks as are involved in heating water by an immersion heater.

### Acknowledgement

Thanks are due to Shri Ved Ratna, Professor of Physics, NCERT, for his guidance in writing this paper.

# The Mangrove Otter of Sunderbans

P. SANYAL
**Assistant Chief Conservator of Forests**
**Calcutta (W.B.)**

---

*In the year 1985 in the month of August a wonderful scene of group fishing of otters was observed at the inner estuarine zone near northern boundary of Sunderbans Tiger Reserve On being approached, one adult female came on to shore and three freshly born pups were found The pups had their eyes closed. After about a week they opened their eyes and weighed 155 gm on average*

---

## Introduction

The Sunderbans is the largest prograding delta on globe situated at the estuarine phase of Ganga-Bramhaputra River system The present intertidal area of Indian Sunderbans extends over 9630 sq km out of which 4262 sq km still remains as Mangrove Forest area, which represent 61% of India's total mangrove forests The forest areas are crisscrossed by innumerable creeks and rivers and the average water area is 35% (Sanyal, 1987). The Indian Sunderbans now gets only a trickle of fresh water from the Bangladesh river Ichhamati and the river Hoogly along eastern and western boundaries. During 12th to 16th century, the Bengal basin suffered a neotectonic movement and tilted eastwards. The main flow of the river Ganga started coursing through the river Padma of Bangladesh. During this period there developed anastomasing network of rivers and creeks between Ganga and Padma rivers and the aquatic life forms became extremely important for Indian Sunderbans The water salinity of Indian side slowly increased causing the extinction of a number of plant and animal species. The Javan Rhino (*Rhinoceros sondicus*), Water Buffalo, One-horned Rhino, Swamp Deer, Gharial, Chitra Turtle (*Chitra indica*) got extinct only during last hundred years But the animals which could survive the atrocities also include a good population of Otters Among the aquatic mammals, the Gangetic Dolphin (*Platinista gangetica*), Black Finless Porpoise (*Neomeris phocoenoides*) and Common Dolphin (*Dolphinus delphis*) are thriving in the creeks of Sunderbans. The Smooth Indian Otter (*Luthra perspicilliata*) locally called 'Dhere' also competes with them for fish hunting in the saline creeks of Sunderbans.

## Sunderbans Otters

The highly saline creeks in the Mangrove Tigerland of Indian Sunderbans harbour the adaptable species like Smooth Indian Otter. The salinity of creek waters rises to more than 50 m mohs (E C.) during the month of April to June and on an average it is around 30 m. mohs (E.C). Normal habitat of Smooth Indian Otters hardly exceeds 15 m mohs (E.C.) anywhere in India. The fish and shell fish population predominantly include *Peanaeous monodon* the Tiger Prawn, the Mullet fishes like *Mugil persia*, *M taede*, Sea Bass (*Lates calcarifer*), and various snappers and cat fishes The Euryhaline fish population form indeed good food for the Sunderbans Otters The otters are often trained by the local fishermen (Anderson, 1879) for catching larger Mullets in particular. It is, however, believed locally that these otters have a preference for nonscaly cat fishes which are voracious predators of lunchdish fishes. Thus, the otters get a moral protection on this issue.The intertidal waters of Hoogly have been canalized inside some villages of Howrah district. Recently, two numbers of fishing cats were killed in a reed bed (Phragmites) along such canal in Panchla P S. of Howrah district. The survey of the place revealed presence of a large number of Smooth Indian Otters. The local people on interrogation confirmed the same belief that they are keeping a check on the population of predator fishes (cat fishes)

In the year 1985 in the month of August a wonderful scene of group fishing of otters was observed at the inner estuarine zone near northern boundary of Sunderbans Tiger Reserve. On being approached, one adult female came on to shore and three freshly born pups were found. The pups had their eyes closed. After about a week they opened their eyes and weighed 155 gm on average. The pup reared at Sajnakhali location gives an indication of the size (20 cm, tail to nose).

The population survey has not been done systematically. But the sighting frequency indicates a larger distribution at the inner estuarine side. The mid-estuarine zone, i e., 20 to 40 km away from estuarine mouth of Bay of Bengal also harbours the Smooth Indian Otters. But the outer estuarine zone of Indian Sunderbans (0 to 20 km away from estuarine mouth) did not provide so far any evidence of the presence of the otters. The collection of specimens of Otters at the Calcutta museum confirms presence of Common Otters and even Clawless Otters at Salt Lake area of Calcutta (Jerdon, 1967) which also falls under the intertidal zone. The vast wetlands between Calcutta and the Sunderbans, which only recently lost the intertidal character, harbour good population of Common Otters (*Lutra lutra*). A juvenile common otter was collected during winter by Sri Kushal Mukherjee of 'Prakriti Sansad'. Recently the herpetologist Sri Dipak Mitra reported a juvenile Common Otter collected from the same area during the month of June These two collections throw some light on the different breeding periods of Common Otters in Sunderbans area. Presently, the vagaries of changed conditions of Indian Sunderbans in recent times have given rise to a decrease in population of last two species of Otters in Sunderbans proper. Everything said and done, the vast aqua-terrestrial area of Sunderbans Mangrove still demands a proper, intensive survey to ascertain exact status of all three species in the wonderful tigerland.

### Acknowledgement

Author is indeed grateful to Sri Kushal Mukherjee of 'Prakriti Sansad' for helping with his valuable experience of Otters within east Calcutta wetlands. Thanks to the members of Indian Society for Wild Life Research for narrating their experience of Otters of Panchla P.S. in Howrah district.

### References

1 *First Working Plan of 24 Parganas Forest Division*, West Bengal, 1949-50 to 1958-59.

2. Anderson, J. (1879), "Anatomical and Zoological Researches Comprising an Account of Zoological Results on Two Expeditions to the Western Yunan in 1868 and 1875 and the Monograph of Two Cetacean Genda, *Pletinista* and *Orcella*", Vol I, Published by B Quaritch, London. p. 209.

3 Chakraborty, K (1979), ''Ecology of the Sunderbans Tiger with Particular Reference to Range of Habitats and Adaptability to Changes'', *Cheetal*, 20/2 & 3.

4 Jerdon, T.C. (1967), *The Mammals of India*, Roorkee

5. Morgan and McIntire (1959), ''Geology of the Bengal Basin'', *Bull Geol. Soc Am.*, **70**· 31-342.

6. Mukherjee, A.K. (1975), ''Sunderbans of India and its Biota'', *J. B N H S*, **72** (1), 1-20

7. Sanyal, P. (1987), ''Managing the Man-eaters in the Sunderbans Tiger Reserve of India—A Case Study'', *Tigers of the World*, Noyes Publication, U.S.A, pp. 427-434

# Measuring Reflection Factor of a Flat Surface

VED RATNA
**Professor**
**Department of Education in Science and Mathematics**
**NCERT, New Delhi 110 016**

*During consideration of Indian Standard Specification for blackboard for classroom use, ambiguity arose about the method for measuring the reflection factor for the blackboard. What do we understand by this term? A simple method devised by the author to measure it for a matt surface is described here. During this work, a simple device to produce nearly ideal diffuse illumination on a flat surface was made, which is useful for other purposes too.*

## The Meaning of Reflection Factor

The meaning of the term 'reflection factor' depends very much on the context in which it is being used. When a plane surface separates a transparent denser medium (e.g a glass slab) from air and a parallel beam of light is incident normally on it, the fraction of incident energy reflected back into air is

$$\rho = \left(\frac{n-1}{n+1}\right)^2$$

where $n$ is the refractive index of the denser medium. This reflection factor is strongly dependent on angle of incidence and approaches unity as the angle of incidence approaches 90°.

Next, suppose instead of a transparent medium, we have a black opaque medium whose boundary surface with air is flat and highly polished, e.g. a plastic sheet of black colour Like a plane mirror, a parallel beam of light incident on it is reflected as a parallel beam according to laws of reflection. Its reflection factor, i.e , fraction of incident energy reflected back into air, behaves in a manner similar to that of a transparent medium.

Consider, next, a plate of copper with flat highly polished surface. The fraction of incident light energy reflected back into air not only depends on angle of incidence, but also very strongly depends on the wavelength of incident light. The reflection factor is higher for red side of the visible spectrum and is still higher in the infra-red.

In all the above cases we could talk of another reflection factor too, viz., the reflection factor for ideal diffuse illumination. Let us clarify first what is an ideal diffuse illumination

Referring to Fig. 1, $ABCD$ is a flat reflecting surface, on which light is incident in all directions. Consider a small surface element $ds$ and the

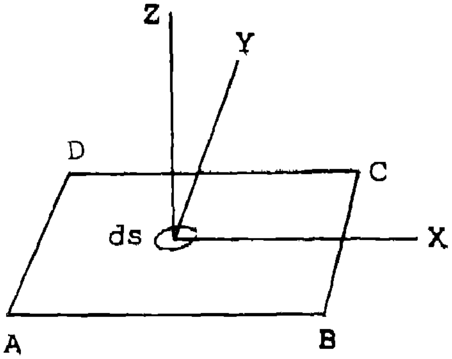


Fig. 1

Cartesian coordinates at this surface element Consider light energy incident on $ds$ in a solid angle $d\omega$ in a direction having direction cosines $l, m, n$ with respect to $X$, $Y$ and $Z$ axes respectively.

$$dE = E(l,m,n)\; ds\; d\omega$$

If the energy function $E(l,m,n)$ does not depend on $l$ and $m$ and is proportional to $n$, then the surface has ideal diffuse illumination.

If a surface has ideal diffuse illumination on it, the fraction of incident energy reflected back into air may be termed as reflection factor for ideal diffuse illumination In considering the energy reflected back from the surface element $ds$, we are summing up the energy sent back by this surface element in all directions. It is not necessary that energy sent back by this surface element may be proportional to direction cosine $n$ For example, if the surface $ABCD$ is a highly polished black surface, then energy sent back close to the normal $OZ$ may be quite small

In everyday life, when we talk of colour and shade of a surface, what we are concerned with is closer to the reflection factor for diffuse illumination and dominant colour in the light energy sent back by the surface element $ds$, assuming that incident energy distribution as a function of wavelength is identical to that in daylight (i.e., light received by us from sun)

In case of a matt surface, again, the reflection factor for diffuse illumination only is relevant Moreover, in an ideal matt surface, the energy sent back by surface element $ds$ in a small solid angle $d\omega$ will be independent of direction cosines $l$ and $m$ and will be proportional to $n$. Thus the luminance of the surface element $ds$ seen in any direction will be the same

### Measurement of the Reflection Factor for Diffuse Illumination for a Matt Surface

For this measurement, a simple device for providing nearly ideal diffuse illumination may be improvised Referring to Fig 2, $ABC$ is a circle made of wire. It is of about 25 cm diameter. $DEF$ is another identical circle The two are joined together by three wires $AD$, $BE$ and $CF$, each of 25 cm length. Thus we get a wire cylinder whose height and diameter are 25 cm each.

$GHI$ is another smaller circle of diameter about 8 cm It is attached concentrically with the circle $DEF$ by three radial wires Then, leaving the inside of circle $GHI$ open, the area between the circles $DEF$ and $GHI$ is covered with translucent tracing paper. Also the cylindrical surface formed between circles $ABC$ and $DEF$ is covered by tracing paper Inside area of the circle $ABC$ is left open

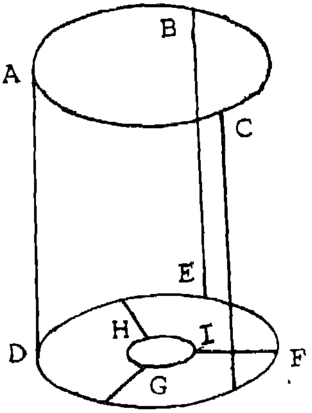


Fig. 2

To produce diffuse illumination on a flat surface, the device is placed on it with circle $ABC$ resting on it (Fig 3) The outside light falling on the translucent screen is transmitted inside and is scattered in all directions To provide uniform illumination on the translucent screen it is better to illuminate it by at least three lamps (Fig 4)

The flat surface may be seen through the window $GHI$ by a light measuring device (e g., a

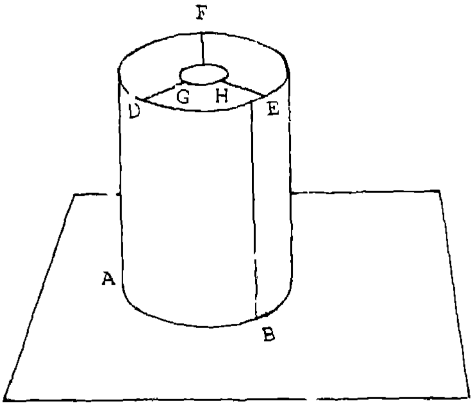


Fig. 3

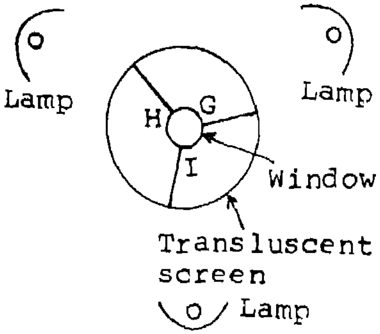


Fig. 4

spotmeter or an SLR photographic camera with exposure-meter in it). Thus the luminance, $L$, of the surface along the normal may be measured

The experimental flat surface is now replaced by a standard matt white surface whose reflection factor, $\rho_\omega$ is known. If we take a good matt white paper (e g., good white paper used for making electrostat copies of documents), its reflection factor is between 85% to 95% Using the same light measuring device and the set up for illumination, the luminance, $L_\omega$ of the white surface is now measured. Then the reflection factor, $\rho$ of the experimental flat surface is:

$$\rho = \frac{L}{L_\omega}\rho_\omega$$

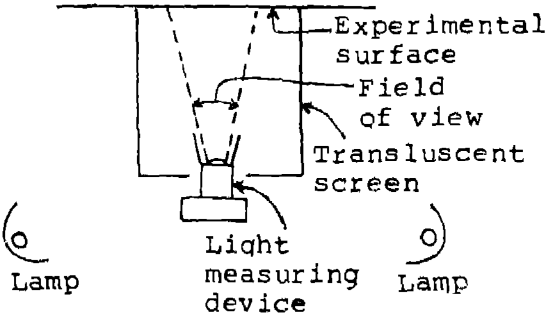


Fig. 5

In this method, it is important to take precaution that the light measuring device does not receive any light from the translucent screen For the purpose, it should look at only the central portion of the illuminated surface (Fig. 5), say, a circle of about 10 cm to 12 cm diameter. Also, the objective lens of the light measuring device should have a hood on it, so that no light from the translucent screen directly falls on the lens

Using this method reflection factors for a blackboard and a green board in the Physics Laboratory of the Department of Education in Science and Mathematics, NCERT were measured Results were respectively 0.15 and 0 25. The probable error of measurement (due to estimated reflection factor of white paper and probable error in measurement of luminance using the Nikon-F Camera) was estimated at ± 25% It was also found that any residual chalk dust left after cleaning the board by a clean cloth, affects the result very much and is a major source of error.

## Measuring Reflection Factor for a Polished Plane Surface

To measure the reflection factor for a polished plane surface for light incident at a certain angle we need a collimated beam of light An arrangement similar to that in the optical disc can be used Referring to Figure 6, the collimator sends the incident beam on the experimental surface at the desired angle of incidence, *i*. This beam reflects at an angle *r* with respect to the normal to the surface according to laws of reflection The reflected beam is received by a light measuring device This intensity of the reflected beam is measured.

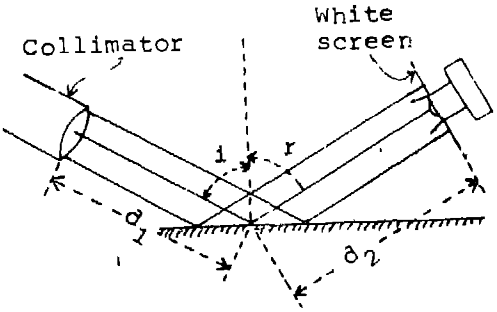


Fig. 6

Next the light measuring device receives direct beam from the collimator (Figure 7). If $d_1$ is the length of incident beam and $d_2$ the length of reflected beam in the case of reflection from the experimental surface, then the length of direct beam falling on the light measuring device is kept $d_1 + d_2$.

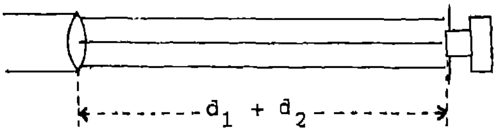


Fig. 7

The intensity of the beam may not be uniform all over its cross-section. Therefore, the intensity in the centre of its cross-section is measured in both the cases, where usually the intensity of the beam is maximum. Thus while the light measuring device receives the beam of light , a white screen with a hole in the centre may be mounted on it It is then easily checked up that extra light of the beam, which does not enter the light measuring device, illuminates the screen symmetrically around the hole in it (Fig 8) Another possibility is that the eliminator gives a rather thin pencil of light, the entire cross-section of which enters the light measuring device.

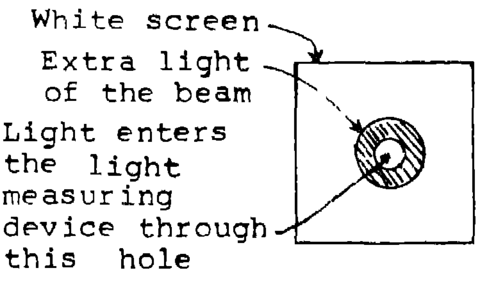


Fig. 8

### The Case of Common Flat Surfaces

Flat surfaces that we commonly come across in life are usually neither ideal matt nor ideally polished. Surface of fine chalk powder (or any other powder) spread evenly on a flat surface approximates to an ideal matt surface. Surface of glass or looking glass or a highly polished plate of plastic may approximate to an ideally polished surface

Paper used for writing is supposed to be matt Let it be tested in the set-up shown in Figure 6, with an angle of incidence of 45°. Then the reading of the light measuring device when kept along the normal may be as much as half the corresponding reading when it is kept at same distance in the direction in which reflected beam according to laws of reflection will go. Thus the paper has some specular reflection i.e., greater luminance along the direction of reflected beam Glazed paper has much larger specular reflection.

Using a camera with a tele-lens as the light measuring device, experience of the author with blackboards is as follows. With angle of incidence of incident light between 40° and 50°, if the luminance reacting along the normal is less than ¼th of that along the direction of reflected beam, then the blackboard is quite uncomfortable to use.

### Some More Applications of the Device for Providing Diffuse Illumination

i) A device similar to the one described above for providing diffuse illumination was first made by the author in 1981 in connection with developing a strategy for production of tape-slides programmes in Science (1). Under that strategy the art work is done on tracing paper and there are chances that wet ink used in making the drawings causes shrinkage at some places in the tracing paper. This results in production of wrinkles in the paper on which artwork is made. Ordinarily, the photograph of the artwork with wrinkles will be rather ugly. Diffuse illumination provided by this device completely washes out the wrinkles and photograph is that of a faultless artwork. Likewise any graphics on a wrinkled paper or any other surface can be reproduced with fine details, eliminating the wrinkles.

ii) You have a very old valuable document, say, a photograph printed in a newspaper The surface of paper is quite rough You want to wash out the roughness and grain of the paper but reproduce finest details of the photograph—every dot which makes the printed picture If your camera can photograph such fine details, chances are that the photograph will show up all the fibres of the paper too, which makes a very ugly background. But if you make nearly ideal diffuse illumination on the documents using the above described device, the roughness of the paper will be washed out and finest details printed in ink can be photographed with a clean background.

Acknowledgement

The author expresses his gratitude to Dr. P.K Bhattacharya and Dr. B.K. Sharma and their colleagues in the Workshop Department, NCERT for fabricating the device for producing diffuse illumination. Thanks are also due to Shri T.S. Verma, Laboratory Assistant for his cooperation and assistance in fabricating the equipment and in experimentation.

### Reference

1. Ratna, Ved and Agarwal, J.P , "A New Strategy for Production of Validated Tape-Slide Programmes in Science", *Journal of Indian Education*, September 1981, pp. 49-56.

# Case Studies of Products, Processes and Systems as Science Projects at School Level

LALIT KISHORE
**Principal**
**Kendriya Vidyalaya No. 2, NFL Township, Bathinda**

---

*Before a case study is taken up as a part of science projects, the case should be explicitly stated and approved by the teacher. Also, various tools like interviews, questionnaires, opinionnaires, surveys, and access to records and resources should be worked out. After having done all this spade work, the student should proceed on to recording observations. This should be followed by writing a complete project report.*

---

Generally, in most schools, where science projects are carried out, the students either construct working models or do investigatory experiments. It has been observed that because of the lack of project ideas, there is a repetition of the same work over the years leading to intellectual dishonesty.

Also, many schools do not have the appropriate and sufficient inputs for carrying out laboratory and workshop-based science projects. In such a situation, it will be wiser to suggest to the students to carry out science-related case studies which require field work and direct contact with persons and systems to impart the most of the skills and inculcate the values which laboratory-based projects do (Kishore, 1987).

## What is a Case Study?

The case study method is an individualized learning procedure dealing with the study of various aspects of a real or hypothetical situation. It provides the student a problem-solving situation in a meaningful way. While working on a case study project, the student is required to collect observations, analyse them and make recommendations for decision-making.

Williams (1984) adds that case studies can be more than just a problem and its solution, an issue or its action.

They can be initiated and developed by students themselves rather than imposed by the teacher.

## Project Ideas

A large number of case studies can be thought of which concern the school and the community. It will be appropriate to suggest here a few such topics so that those interested in these types of projects may pick up the threads:

1. A case study of electric installations in the school.
2. A case study of the school water supply system.
3 A case study of the school drainage system.

4 A case study of the dimensions of the classroom in terms of space and light per student.
5. A case study of the maintenance of school building.
6. A case study of the plants and trees in the school.

Some further ideas can be developed from the following key words:

1. Noise pollution
2. Air pollution
3. Water pollution
4. Environmental changes
5. Electric power demands
6 Fuel demands
7 Development of a factory
8. Development of a process
9. Improvements in a product
10 Electric grid system
11. Canning of food
12. Bottling of soft drinks
13. Recycling of waste
14. Use of pesticides
15. Construction plans of houses
16 Public transport system
17 Public telephone system
18. Public conveniences
19. Postal service
20. Pressure cookers

### Guidelines and Advantages

Before a case study is taken up as a part of science projects, the case should be explicitly stated and approved by the teacher. Also, various tools like interviews, questionnaires, opinionnaires, surveys, and access to records and resources should be worked out. After having done all this spade work, the student should proceed on to recording observations This should be followed by writing a complete project report.

A science-related case study project has quite a few advantages Besides developing higher cognitions like application, analysis and synthesis, it brings students in contact with the real world It also develops self-responsibility and self-direction on the part of the student along with sharpening of his learning and social skills.

### References

Kishore, L. *Investigatory Projects in Physics*, New Delhi Educational Planning Group, 1987

Williams, A. *Projects' Skills and Strategies*, Melbourne, Pitman Publishing Ltd , 1984

# On Process-based Science Instruction

A.C. PACHAURY
**Reader in Education**
**Regional College of Education**
**Shyamla Hills, Bhopal 462 013**

---

*National Policy on Education (1986) subscribes to the learner-centred information processing of sciences. This simply means that children should be sciencing, rather than listening to the history of sciences in the classrooms*

---

Much of the school science is not at all *sciencing* (Lansdown et al , 1971) to the pupils. Rather, science is presented as a catalogue of facts, to be memorized and subsequently regurgitated on the test sheets or examination copies. This instructional strategy of science teaching is contrary to the processes of science Science is a product and a process simultaneously (Pachaury, 1989), and, therefore, ignoring the latter reduces science merely to factual knowledge. 10 year compulsory science for all, as well divorces the pupils from acquiring the necessary processes and effective thrusts. But, instead of this emphasis, pupils are lashed with the higher and complex scientific abstractions, for which most of them are developmentally not ready to assimilate this knowledge, because of their firm entrenchment into the concrete mode of information processing (Pachaury, 1988) National Policy on Education (1986) subscribes to the learner-centred information processing of sciences. This simply means that children should be *sciencing*, rather than *listening to the history of sciences in the classrooms* (Pachaury, 1985) For the *iconics*, ideally then, hands-on experiences are desirable However, at times, teachers may present alternative formats for the nurture of the processes of science in the pupils. In this inquiry lesson, an attempt has been made for providing pupils experiences of inferring, interpreting and generalizing. This activity is merely a suggestive one. It is hoped, ingenious teachers would design many other process - based activities for their pupils A small reference note is also provided for the use of the interested teachers.

## INQUIRY LESSON ON INFERRING, INTERPRETING AND GENERALIZING PROCESSES

**Topic:** Mosquito Menace Around Us

**Grade:** IX

**Major Objectives:** After completion of this inquiry lesson, the pupils would be able to.

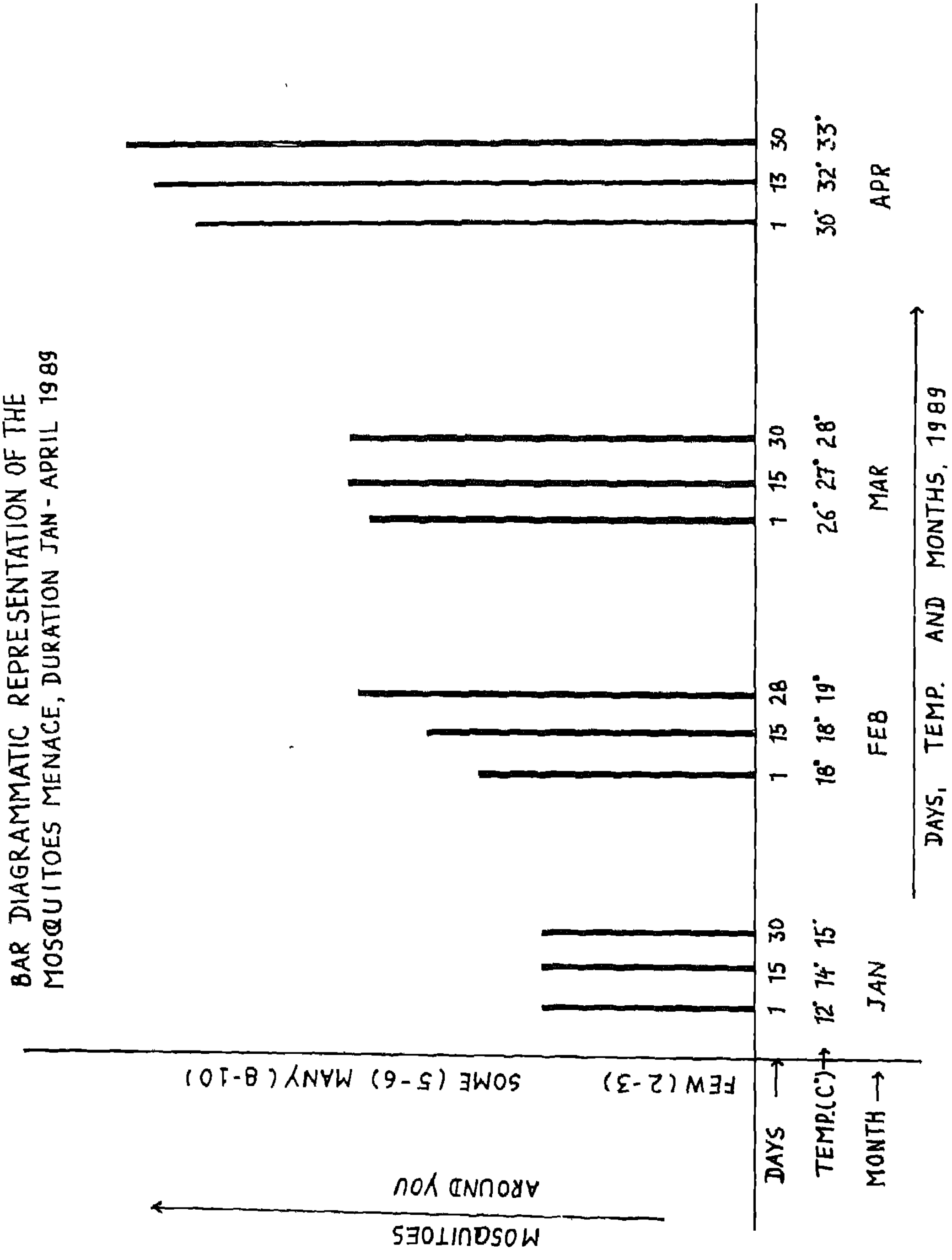
- draw inference on the basis of bar diagrammatic representation,
- interpret bar diagrams, and
- establish a generalization regarding mosquito menace and rise in weather temperature.

### Entry Behaviour

Before this exercise is taken up, children should have some experience of constructing a bar diagram.

Pupils have experienced mosquito menace in different months of the year.

BAR DIAGRAMMATIC REPRESENTATION OF THE MOSQUITOES MENACE, DURATION JAN - APRIL 1989



Quantification of the objects in relation to few, some and many.

### Materials

A bar diagrammatic representation of mosquito population over the months of January to April, 1989.

### Presentation

Children would be asked to identify the elements of the bar diagram, i.e., the months (Jan-April), *few* (2-3), *some* (5-6) and *many* (8-10) mosquitoes in relation to different days of these months, and temperature on different days of a month.

### Drawing an Inference

1. When was the number of mosquitoes around you the minimum?
2. What was the number of mosquitoes around you on the 15th of March?
3. When was the number of mosquitoes the maximum around you?
4. During which month were only some mosquitoes around you?

### Interpretation of Bar Diagram

5. Why were there only a few mosquitoes around you in the month of January?
6. Why were there fewer cases of malaria in January than in April in the city?

### Establishment of a Generalization

7. Why had there been a change in the population of mosquitoes from January to April?

### Reference Notes

1. *Sciencing* is "engaging in exploration of the material universe for the purpose of seeking orderly explanations of the objects and events and testing these explanations." (Lansdown, B., P.E. Blackwood and P.F. Brandwein (1971), *Teaching Elementary Science*, New York: Harcourt Brace Jovanovich, Inc.). The word 'sciencing' was used earlier by Brandwein, P.F., F.G. Watson and P.E. Blackwood in their book, *Teaching High School Science. A Book of Methods*, New York. HBJ, Inc., 1958
2. "... in good science teaching children should make inquiries, investigations, should make descriptions and explanations, and should make predictions It might follow that teaching which denies children a variety of opportunities to '*be like scientists*' is neither *science* nor *science teaching*" [Blackwood, P E (1964)], "Science Teaching in Elementary School", *Science and Children*, 2, 1, 21-25
   Blackwood has as well suggested the following as the behavioural indices of creating *sciencing*·

   Hypothesizes
   Induces
   Deduces
   Speculates
   Analyses
   Selects data
   Designs
   Experiments

   Reflects
   Proposes
   Criticizes
   Convinces
   Invents
   Guesses
   Comprehends
   Doubts

   Incubates
   Predicts
   Estimates
   *Explains*
   Appreciates
   *Infers*
   Abstracts
   Synthesizes

   Formulates
   Intercorrelates
   *Generalizes*
   Forecasts
   Extrapolates
   Interpolates

   and *communicating sciencing* through such behaviour as tabulating and graphing.
3. Inquiry skills should be an essential outcome of science instruction (Welch et al., 1981). These skills include observing, classifying, measuring, predicting, *inferring*, forming hypotheses, *interpreting data*, correlating variables and experimenting (Cain and Evans, 1984).
4. *Inferring* is not only a basic skill in science (Agin, 1979· McGalliard and Cooney,

1979), but also a process that is fundamental to *interpreting events* (McGalliard and Cooney, 1979). Inferring is included in science education programmes from the elementary grades to the University level (Gallagher, 1979; Medve et al., 1985) Nearly 40% of even 17-year-olds find it difficult to draw inferences from written material (Kormondy, 1985).

5 Children, who are sciencing, construct mental models of reality to 'fit' their observations rather than match with reality Children are not sponge-heads. They process information through *selecting*, *interpreting* and transforming information on the basis of their past experiences and hypotheses. Hence, knowledge is constructed in the mind of the learners.

6. 'Knowledge that, how and why' (Hudson, 1986).

*Knowledge that* deals with the facts, happenings and phenomena

*Knowledge how (to)* is related to skills, processes and abilities.

*Knowledge why* involves interpretations, making mental models and analogies, and theories etc.

7. "Cultivation of both the cortices of human brain through science education would then require a judicious blend of the conceptuals and syntactical (processes) synchronously in curriculum development based on empirical modes of inquiry and developmental characteristics of the learners" (Pachaury, 1988).

8. Science for all "necessitates a process-based curriculum" (Wellington, 1988).

9 Neither realist nor idealist perspective of scientific knowledge is, not only inadequate but instead unwarranted in the context of constructivist paradigm (Pachaury, 1989).

10. Other process-based lessons may be consulted in S.N.L. Bhargava and A.C. Pachaury (1989), (Eds.), *Some Exemplars on Activity Lessons*, Extension Services Deptt., Regional College of Education, Shyamla Hills, Bhopal-13.

## References

1. Agin, M L. (1979) "Window of Gold—Basic Skills", *School Science and Mathematics*, 79, 545-546.
2. Cain, S.E. and Evans, J.M. (1984). *Sciencing. An Involvement Approach to Elementary Science Methods*. Columbus, OH. Charles E. Merrill Pub. Co.
3. Gallagher, J.J. (1979). "Basic Skills Common to Science and Mathematics", *School Science and Mathematics*, 79, 555-565.
4. Hudson, D. (1986). "The Nature of Scientific Observation", *School Science Review*, 68, 242, 17-29.
5. Kormondy, E J. (1985). "Science Education The Challenge of the 80s", *American Biology Teacher*, 47, 7, 402-409.
6. Lansdown, B. et al. (1971) *Teaching Elementary Science*, New York: Harcourt Brace and Jovanovich, Inc.
7. McGalliard, W. and Cooney, T.J. (1979). "Inferring and Predicting—Some Activities", *School Science and Mathematics*, 79, 602-609.

8. Medve, R.J. et al. (1985). *Biology 100*, Slippery Rock, PA· Slippery Rock University.
9. *National Policy on Education* (1986). Government of India, Department of Education, MHRD, New Delhi.
10. Pachaury, A C. (1985). "Piagetian Theory and Physics Teaching at +2 Level". Paper presented at the orientation of key persons engaged in Physics teaching at +2 level in Madhya Pradesh. Regional College of Education, Bhopal-13.
11. Pachaury, A.C (1988). "Right Cerebral Laterality in Indian Children", *School Science*, **26**, 2, 23-28.
12. Pachaury, A.C. (1989). "Cognitive Developmental Perspective and Learning of Science by the Disadvantaged Child", in *Teacher Education for Disadvantaged Children*, J.S. Grewal et al. (Eds.), Report of National Workshop on Reforms in Teacher Education, October 3-12, Regional College of Education, Bhopal-13.
13. Welch, W.W. et al. (1981). "The Role of Inquiry in Science Education. Analysis and Recommendations", *Science Education*, **65**, 1, 33-50
14. Wellington, J.J. (1988). "The Place of Process in Physics Education", *Physics Education*, **23**, 150-155.

# Puppets versus Drugs

EDITH MASSÜN

*Mexico's Youth Integration Centres are tackling drug abuse within the community itself, in the conviction that only if the community is involved can it become responsible for its own health.*

Centros de Integración Juvenil (CIJ) is a health-sector institution that was started in Mexico city in 1970 specifically for the prevention of drug abuse and the treatment and rehabilitation of drug-dependent persons. It is one of the largest specialised centres in Latin America, with over 16 years of field experience. There are now 32 local Youth Integration Centres sited at strategic points around the country, generally in the most densely populated towns. They employ a regular staff of some 600 and several hundred volunteers

CIJ's somewhat unconventional organizational structure ensures that it is in constant touch with the needs of the community and, at the same time, gives its managerial and professional staff the necessary stability of tenure. Though officially recognised and subsidised from the federal budget, CIJ does not come directly under the government; it is a civil association, directed by a 'National Board of Management' on which sit members of the community. This system also obviates one of the problems that beset many Latin American Institutions: the replacement of their managerial staffs with every change of government or administrative re-shuffle.

The structure of the CIJ reflects its approach to drug abuse. It defines drug abuse as a public health problem symptomatic of individual, familial and social stresses, and to resolve it will call for the active participation of the population. The mere fact of belonging to a social group or milieu in which drug abuse is a problem implies that each of its members shares some responsibility both for the genesis of the problem and for its solution. Only to the extent that society involves itself in tackling the problems that affect it will it be possible to solve them  Intersectoral coordination and community involvement are two essential guiding principles in the prevention and treatment of drug dependence, but few institutions manage to put them into practice. I asked the Medical Director of CIJ, psychiatrist Raul Zapata, how he gets the community involved.

He told me: "It is a whole process that begins with informing and alerting opinion, continues with a guidance phase, and culminates at a more complex level of in-depth action which is the training phase  The most complex part of this process is training prevention officers, (who include heads of families) so that they can guide their children, and training health officers who are in touch with the community so that they can identify those at risk and help those who already have a problem.

"The idea is for them to be strategic elements of the community who are progressively sensitised to the drug abuse problem and in turn generate awareness by a 'snowball' effect. Parents who are conscious of the problem will influence not only their own child but others too; a teacher will influence a new group of pupils each year ... Our objective is to have people forming completely self-run groups that can design their own preventive programmes within their own communities.''

It often happens that certain people use the information they receive to launch out into alarmist or sensationalist anti-drug programmes, which can do more harm than good. Many people in Latin America want to combat 'drug trafficking' without knowing how to distinguish between trafficker and consumer, delinquent and sick person. I asked how such misdirected initiatives and counter-productive activities could be avoided.

Dr Zapata replied: ''It is true that people always prefer to involve themselves in 'blitzkrieg' campaigns (with slogans like 'Let's fight the drug traffickers!') rather than committing themselves to serious, longer-term activities. It is also true that the drug scene fascinates the public Everyone wants to know about their effects, but very few ask what is the reason for drug abuse and what can be done to prevent it.

''The information meetings or talks we start with serve as an initial 'screening' to show us who it is possible to work with. Mostly they are people already with a high level of awareness, concerned for the welfare of their group. community leaders, social workers and so forth We know that a group is ripe for us to 'set it loose', and even to support it with our entire infrastructure, when its members really understand that drug abuse cannot be prevented by taking the easy path of 'yellow' journalism or trying to lay the blame upon others.

''In addition to the trained volunteers from the community, we make a point of including young assistant teachers (students of psychology, social sciences or social work) in the preventive activities This not only saves staff resources but it is also in keeping with the philosophy of our institution.''

In a country as large and heterogeneous as Mexico, with 18 million people in the capital alone, how far can the Youth Integration Centres go in this 'social mobilisation' against drug abuse?

''The problem of drug abuse is so complex that no single institution can take on the whole gamut of activities that are needed,'' said Dr. Zapata. ''We must see to it that all the other institutions do something, each in its sphere of competence. We constantly try to involve other agencies in our programmes, particularly the Ministries of Health, Education and Labour, but at the decision-making level so as to have all the necessary support.''

A visit to one or two of the 32 local CIJ centres can only give an incomplete impression of a whole gamut of activities that are conducted daily on and off the institution's premises. The CIJ's work ranges from scientific research on drug abuse problems, through preventive programmes, and treatment and rehabilitation of drug dependent persons, to continuous training of volunteers and of its own regular staff Every local centre carries out all the phases of comprehensive care for those with drug dependence problems, from the patient's admission, diagnosis and treatment by various techniques or therapeutic and rehabilitative approaches, to family guidance. And the staff also go out to meet the community their regular activities include talks to inform and alert opinion, street theatre and puppet shows given in the schools

At the Southern Centre in Mexico City, the psychologist S. Cisneros was getting ready for one of the daily guidance sessions for the families of drug dependents. ''Here we bring together the closest relatives of patients who are undergoing individual treatment at the centre,'' explained Mr. Cisneros. ''With family members, the primary objective is to lessen their anxiety and then to change their idea of what drug dependence is. Because generally they individualise it: to them the problem is the child who takes drugs. They don't understand that it has to do with the social

# Information on Drug Abuse

Access to comprehensive information is a prerequisite for sensible action and policies about drug misuse It was this basic principle that underlay the founding, in 1968, of the Institute for the Study of Drug Dependence (ISDD) in response to the United Kingdom's first wave of public concern about drug abuse in the 1960s Over the years the Institute has provided valuable advice to WHO on a variety of technical issues in this field,

Apart from its publications, the resources of ISDD are not generally available outside the British Isles, but the Institute is carrying out a computerization programme which will make its library accessible on a more international basis

This library is now one of the largest and most comprehensive collections of scientific, academic and other documents on substance abuse in the world, numbering some 40,000 articles and books. The indexing system is unusually heterogeneous and multi-disciplinary. An end-product of this work is ISDD's *Thesaurus of Indexing Terms*, already available in English and Spanish, with a Portuguese version in the pipeline and a prospect of a French version later. This indexing tool enables material to be retrieved from the library on any topic, when eventually the library database is transferred on to computers, it will be accessible to researchers and information seekers outside the UK.

Besides the library's facilities, ISDD has an experienced professional information staff who deal with some 8,000 individual enquiries each year, ranging from school and university students for help with essays and theses to requests from policy-makers and researchers for material relevant to their current interest. The needs of the latter are also catered for by the monthly publication of selected abstracts of the library's latest acquisitions, selections from material published in the UK press, and a listing of all documents and books added to the library each month.

Wider dissemination of information on drug misuse is achieved through a comprehensive range of booklets and brochures aimed at particular audiences, such as social workers, schoolteachers, parents and family doctors, whose occupations bring them into contact with drug problems The library ensures that these publications present an up-to-date and balanced account of the facts of drug misuse, while ISDD's journal *Druglink* is available internationally and serves to keep its readers abreast of developments in UK policy and practice on the misuse of drugs

ISDD's Research and Development Unit aims to support the growth of knowledge and competence among those who work with drug problems. It concentrates on social research in the areas of prevention, evaluation of education and social work, and development of tested training and teaching methods and materials.

ISDD seeks to be a credible source of information and support to everyone concerned with drug misuse. It therefore takes great care to remain independent from government (though it does receive some of its finance from the UK government) and from any faction, and generally refrains from expressing opinions on issues of drug policy The Institute, based at 1-4 Hatton Place, London EC1N 8ND, is of potential interest to other countries as a model institution to support their national response to the misuse of drugs

*Courtesy* WHO

and above all the family environment. We have to analyse with them their own attitude towards the problem."

The mother of 'Tonito' (aged 14) is a 46-year-old peasant woman who has brought up her 11 children alone. Obviously this is the first time in her life that she can talk about her problems and her doubts to someone who really listens. "My husband never had time to help me about the house.... When Tonito had the accident as a little kid ..." The psychologist listens and asks questions only to set her thinking· "And how do you feel about it? Is there anything more you can do?"

After an hour and a half, Tonito's mother begins to understand her son's problem better and feels there is something she can do to help him. She agrees to come back next week and report on what she has been able to achieve

The Netzahualcoyotl Centre is in an outer suburb where two million people live in deprived conditions. There I witnessed one of the most interesting outside activities conducted by a particularly dynamic team. The object of the exercise was to convey a preventive message to children at one of the local primary schools through the medium of puppet theatre. The play, entitled 'The Champions' and written by the Medical Assistant Director of CIJ, is about abuse of pep pills and tranquilizers

Four children are getting ready for a race One takes some pills to overcome his fear, another to feel stronger and thus beat the others. The race begins—but one of them falls asleep before even starting to run, and another has a terrible headache and has to stop in the middle of the race. The winner is Gustavito, the only one who has taken no pills and is in the habit of eating properly and doing exercises.

The CIJ team (including several volunteers) arrive at the school in the middle of the break. They start getting the theatre ready and putting on make-up in front of the children so as to attract their attention The drawing power of the show for the children never fails! In a minute they are all around the team watching the preparations and asking questions. As the event has been publicized in the district by poster, some of the school children's neighbours and parents also arrive, with their smallest children in their arms.

During the performance the children are not just passive spectators; they are constantly invited to participate. The puppets address them, ask what they think about what is happening on the stage and make them take part in the action. Fascinated, the children readily forget that what they are watching is only a play and take it for a real-life happening. When they are asked which of the four main characters they would most like to resemble, they all shout in unison: "I want to be like Gustavito, so as to win!"

Clearly, the preventive message 'came across' and reached those it was intended for much more surely and probably to more lasting effect—than if they had merely been passive recipients of a lecture on the dangers of pills. When the play is over, another surprise awaits them: the puppeteers suddenly appear before the audience, each holding his or her marionette. They make them move and talk, inviting the children to come and visit them at their district CIJ centre, where they will teach them how to make puppets and act plays with them. This way of publicising the centres never fails, because it appeals to the children through an activity that really pleases and interests them.

The puppeteers are already packing up their gear and removing the white grease-paint from their faces, but the children are still clustered around them, hoping they won't go away just yet. Once their interest is aroused, questions and doubts pop out from their little heads like sparks and demands answers. The first step has been taken towards initiating genuine preventive education with these children.

*Courtesy*. WHO

# Difficulties in Implementing Creative Physics Teaching Methods

A.B. SAXENA
**Lecturer in Physics**
**Regional College of Education**
**Bhopal**

*The examination system gives emphasis on the reproduction of the text and this does not test the other aspects than the memory. In such circumstances, it is really too much to expect from the teacher to use creative method The present trend of putting the objective questions mainly of the multiple choice type also does not help the cause of creativity. It is because the questions give an emphasis on convergent thinking, whereas the creativity is related to divergent thinking*

It has been felt by a number of authors that the physics teaching methods employed in schools and colleges do not give a proper emphasis on the fostering of creativity of the students Usually, the stress is on rote memory. The experiments done in the laboratories are performed in a mechanical way and there is little for the student to choose whether it is method or apparatus, what to say of the objectives. When the experiments are done by the previously decided methods, the curiosity of the student is killed and there is little which may develop his problem-solving skill. These are some of the facts which have been observed by many educationists.

## Creative Physics Teaching Methods

Some of the methods which nurture the creativity of the students are as follows:

1 *Seminar-cum-group Discussion Method* In this method, the teacher gives a comprehensive talk covering various aspects of the topics which he wants to teach. When the talk is over, it is followed by a short discussion, in which the teacher also takes part. Students choose different aspects which they want to study. Thus each student individually or in group chooses a specific topic for detailed study. The initial references may be suggested at this stage by the teacher and students are left free to consult the library and do the experiments. The students study the topic thoroughly and give a talk to the whole class. Meanwhile when they are preparing the talk, the teacher is also available for discussion and necessary guidance. The talk of the student is followed by a thorough discussion by the whole class. The role of the teacher in this method is to (i) initiate the discussion and help in choosing the topics (ii) to provide the necessary guidance so that the whole effort does not go waste but it leads to fruitful results.

2 *Problem-solving Method:* Sometimes, it is possible that the whole thing starts with raising of a problem by a student. For example, a student may ask for the reason of observing the colour of thin film. In this case, the teacher has to prepare the necessary background to tackle the present problem by either the talk given by him or the student or

by discussions. When this is done, the next step may be of taking the help of the students in solving the problem raised earlier.

3. *Integration of Theory and Experiments.* In this method, the teacher tries to integrate the theory and the experiments as far as possible. In this approach, students are usually asked to make certain observations and draw conclusions. The theory follows it. For example, while teaching specific resistance, the students are allowed to guess variation of resistance with length, radius etc. Then they design the suitable experiments to test their hypothesis If their hypothesis comes out correct, well and good, otherwise, they make fresh hypothesis and test it They may also draw the conclusion from the observation made by them. When this is done, other related parts of theory follow In some cases, the theory and experiment may go side by side.
4. *Approach for Experiments.* As we have stressed in the beginning, we cannot continue with the method usually employed in the classes. If we wish to foster and nurture the creativity of the students, we have to make a more open and flexible approach. First, the objectives of the experiments should not be fixed as they are today. The objectives of the experiment should be decided on the basis of the interest and needs of the students. For example, while studying the resistance of the electrolyte a student may like to study one of the following aspects:
    a) Variation of resistance of electrolyte with temperature.
    b) Variation of resistance with cross-section of electrodes.
    c) Variation of resistance with concentration of electrolyte.
    d) Variation of resistance with distance between the electrodes.

When the object of the experiment has been chosen by the student, he finds out the way he can do the experiment. Then he draws the conclusion from his observations.

In the other case when the object has been assigned by the teacher, the experiments may be open ended rather than close ended. For example, in case of Boyle's law the student is allowed to find out the relationship between pressure and volume rather than verifying that pressure is inversely proportional to volume. The open ended experiments have the advantage of the fact that they allow the student to draw the conclusion with a free mind and on the basis of his observations. He is not prejudiced to draw certain conclusions before making the observations.

### Difficulties in Implementing the Creative Method

It may be mentioned here that these are some of the methods which try to foster the creativity of the students. The common property of these methods is that they allow for a flexible approach and an open mind. No firm method can be established to teach a topic in advance but can be decided by the teacher depending upon the attitude of the students, and the facilities available. Any other method which has the properties of flexibility and openness is also creative method and may be employed. But there are certain difficulties and obstacles we face while implementing these methods in the classroom We shall now discuss them.

1. Our syllabi are rigid and time allotted to each subject is fixed. There is little scope left for the teacher to use his creativity.
2. Our school/college have very few working days as there are too many holidays. Thus the teacher gets very short time to finish his course. The creative methods of teaching

definitely take more time than the routine methods. Since there is hardly any time, it is difficult for the teacher to take the risk and teach by creative method.

3. The examination system gives emphasis on the reproduction of the text and this does not test the other aspects than the memory. In such circumstances, it is really too much to expect from the teacher to use creative method. The present trend of putting the objective questions mainly of the multiple choice type also does not help the cause of creativity. It is because the questions give an emphasis on convergent thinking, whereas the creativity is related to divergent thinking.
4. One does not know how to evaluate, if the teaching is done by creative methods. The difficulty is that all the students in creative method study according to their choice and interest and it is difficult to use one yardstick to evaluate them. Of course there will be some minimum knowledge acquired by all of them but we cannot ignore what they have studied over and above the minimum. Similar is the difficulty for the practical examination. When the students have performed entirely different experiments with different aims, the present examination system will not work. We have to devise some new evaluation techniques relevant to the creative method.
5. Most of the laboratories are ill-equipped and libraries are poor. For creative method, it is necessary to have sufficiently good laboratory, library and workshop.

What should we do in the face of such difficulties? Should we wait till these difficulties are overcome? No, perhaps that will not be appropriate. We have to start right now in the direction of adopting the creative method as and when our means allow. For example, with limited means we can still improve the method of teaching, make models and charts. However, some thinking is to be done as to how the difficulties listed earlier may be overcome.

The rigid method of teaching is to be dispensed with and more flexibility is to be adopted in the system. The syllabi are to be restructured so that they allow more flexibility to the teacher. Sometimes, when different aspects of the problems are involved, perhaps it will be more appropriate to have team teaching. The teachers have to be provided with more time to teach the same content. This can be done by curtailing the number of holidays; there is no other way if we want to improve teaching in our schools.

The pattern of examinations has also to be modified. The questions are to be of the type which do not give emphasis on memory alone, but also on divergent thinking. For example, the questions of the following type may be avoided:

a) What is pin-hole camera? Explain
b) Show that the amount of heat required to change the temperature of a body of mass $m$, specific heat $s$ by $t$ °C is $mst$
c) Derive the formula $mv^2/r$ for centripetal force.

These questions, as one can see, require the convergent thinking only as they stress upon memorizing the facts, derivation of some equations. These questions should be replaced by questions which give an emphasis on divergent thinking and problem-solving capabilities. For example, the questions of the following type may be better:

a) What difference would there be in the image formed in a pin-hole camera if (a) there are two pin-holes near each other instead of one; (b) there is single pin-hole, but it is twice as wide
b) Calculate the heat required to convert 2 g of ice at −10°C to steam at 100°C.
c) What is it that provides the necessary centripetal force in the following cases?

i) a cyclist rounding a short corner on level road.
ii) earth going round the sun.

At first glance, it may be difficult to find the difference in the type of questions mentioned above and those mentioned earlier. The questions mentioned earlier require the student to repeat the facts in the same way as they are taught in the class, whereas in the later category they have been provided with a novel situation and they are required to solve it. It also includes a question which requires divergent thinking to be used.

As we have pointed out earlier, we have to devise a proper evaluation system before we implement the creative methods of teaching. We should be sure, first of all, what we want to evaluate at the end of term/session/course. Do we intend to evaluate the creative capacity of the student in physics along with his knowledge of the subject? Or do we intend to judge the knowledge of the student in physics only, and our intention of employing creative method is to nurture the creativity of the students and therefore to avoid those methods which directly or indirectly kill creativity. We also wish to foster it side by side whereas our main aim of evaluation is judging how much students have learned. In the first case, where we wish to judge the creative ability of the students also we should provide two types of tests—one to judge the creativity of the student in physics and the other to judge the knowledge of physics. In the second case, we need not give the creativity tests but only the test to judge the knowledge of physics.

By pointing out these difficulties our aim is not to go against the implementation of creative methods, but to make a cautious approach. We want that all those who are for the cause of physics and physics education should consider these points, make a threadbare analysis of the problems involved and chalk out a working strategy We also do not want that lack of funds and resources should come in the way of implementing the programme. We should make a beginning with whatever funds and resources we have and try to implement the methods as best as possible. Lot of creativity can be infested in teaching methods, models and apparatus used. More and more emphasis may be given on the cheap and easily available material.

Lastly we wish to point out the fact that with the implementation of 10+2 system, many of the topics from undergraduate level will filter down to +2 stage. We should utilize this opportunity to make the undergraduate course more intense and the coverage in the horizontal direction may not be given that much emphasis.

The difficulties mentioned above should not deter us in any way from implementing the creative methods but would only help us to chalk out a proper approach for its successful implementation This may help us to improve the quality of physics teaching at undergraduate level by using the creative method.

# Divisibility Test by 7, 11 and 13

PITAM SINGH
**Assistant Teacher**
**Higher Secondary School**
**Dhanpur, Meerut**

Methods to find out the divisibility of one number by another are very useful to solve simple problems of arithmetic. The tests of divisibility of a number by 2, 3, 4, 5, etc. are well known and are used widely by school children. Here is an interesting method of a test of divisibility by 7, 11 and 13.

Let us, for example, take the number 16807 and find out whether it is divisible by 7, 11 or 13.

1. Starting from the right end of the numeral, group the digits into block of three and the rest as a group of the digits into another block.
2. Find the difference between these two.
3. If the difference is divisible by 7, 11 or 13 then the given number is also divisible by 7, 11 or 13.

Here, $\overline{16}\,\overline{807}$. The difference of 807 and 16 is 791 which is a multiple of 7. Hence, the given number 16807 a divisible by 7. The number is not divisible by 11 or 13 as the difference 791 is not divisible by 11 or 13.

If the number is large, then this rule can be applied by repeating the process for the number till we get a 3-digit number. For example, let us consider the number 17557891 and see if it is divisible by 13.

Here 17557891 can be written as

17557 891

The difference between 17557 and 891 is 16666. Again 16666 can be written as

16 666

The difference between 666 and 16 is 650, which is a multiple of 13. Hence the given number 17557891 is divisible by 13.

# Science News

## Healing Power of Laser

The possibilities of applying laser light sources, which emanate tightly bundled, intensive beams, are enormous. In the Federal Republic of Germany, they are made use of by such important branches of industry as mechanical engineering, electrical engineering, chemistry, electronics and medical technology, which together arrive at an annual turnover of 700 billion DM.

The possible applications have been by no means exhausted in medicine in particular. This has been underlined by a number of new therapeutic successes, which have been achieved via laser.

A novel laser technique was, for instance, made use of successfully for the first time anywhere in the world at the Bogenhausen Clinic near Munich in order to enlarge constricted or blocked blood vessels. Two patients, suffering from a serious narrowing of the coronary vessels of the heart and a third with blocked leg arteries were cured by laser rather than the scalpel. The deposits in the affected vessels were loosened and subsequently removed. The advantage of this method is that it reduces the risk causing damage or even holes in the walls of the blood vessel.

The Steglitz Clinic of the Free University of Berlin (West) also reported an operation successfully carried out via laser. For the first time, it was possible to operate on a patient suffering from back trouble using laser under the direct visual control of the doctor. Back trouble here refers to alternations in the spine, brought about by shrivelled or slipped discs between the individual vertebrae

These irritate the main nerves in the patient's back and cause serious pain. In Berlin (West), the troublesome parts of the disc were vaporized by the laser beam In this case too, it was possible to dispense with the surgeon's knife, which does not always come up with perfect success.

Responsible for the overall project of researching laser technology is the Technology Centre of the Association of German Engineers (VDI), which advises applicants and assesses applications. Thanks to this strict application oriented form of promotion and considerable efforts, the Federal Republic of Germany has become the leading supplier of laser systems worldwide, enjoying a share of around 30 per cent of the market.

The medical achievements at Bogenhausen and Berlin-Steglitz have opened up greater fields of application for laser technology.

Courtesy: *German News*

## Black Hole in the Milky Way

Max Planck research scientists in Munich are taking a closer look at Sagittarius and the heart of our galaxy, the Milky Way. Their target, known to astronomers as the Sgr A Complex, seems likely to be a black hole about 25,000 light years away from the solar system. (A light year, incidentally, is the distance light covers in a year. It is about 10,000,000,000,000 km.) So electromagnetic radiation from Sgr A received today was first emitted when Stone Age man was still painting cave walls in Europe and the First Indians settled in America By cosmic standards 25,000 years is next to no time. The image relayed by radiation tens of thousands of years old is merely a snapshot, so to speak. The artificial eye used by the Munich scientists is blind to visible light frequencies They would be unable to see anything ordinarily visible in any case; interstellar dust obscures the light emitted.

In infrared and radio wave frequencies, however, Sgr A comes through loud and clear The radio wave picture is that of a compact source less than three billion kilometres in diameter, surrounded by a mini-spiral of ionized hydrogen This gas envelops the central region over a distance of up to 10 light years The centre of the Milky Way is partly embedded in and surrounded by a ring of hot dust which appears to rotate at a speed of 100 km an hour Its orbit is not regular There are powerful turbulences, and they appear, or so Max Planck scientists surmise, to make part of the gas cloud break loose from the rotation and plummet into the centre. So the signs are that the nucleus of the complex consists of highly concentrated mass. The Munich scientists have arrived at a weight of roughly three million suns, so there seems to be something strange in the centre of the galaxy.

What is it that makes the interstellar ring of dust shine so brightly in the infrared range? The ring of dust is evidently heated by powerful ultraviolet radiation. It is an 'oven' with a temperature of 35000°C and can only be satisfactorily explained in terms of a central source with a power of about 10 million suns.

It certainly seems to be a strange customer, a black hole in the heart of the Milky Way, a mass so condensed that nothing can escape from it The Max Planck scientists may say that the idea of a gigantic black hole is still a mere surmise, but astrophysicists have long felt it may well be the case

Black holes are felt to exist at the heart of other galaxies, cosmic phenomena caused by the collapse of a central mass equivalent to millions of suns. Signals registered by an American satellite in the early 1980s were the first sign that our own galaxy might have a black hole in its heart. They were gamma rays that could only have come from a specific magnesium isotope resulting from radioactive decay of the aluminium isotope, 26.

Measurements taken in the early 1980s were too imprecise to identify the sector of the Milky Way from which the gamma radiation originated New light on this point has been shed by Max Planck Extra-Terrestrial Research Institute in Munich. Scientists are keenly awaiting data to be compiled by the gamma radiation observatory scheduled to be sent into space in 1990 The latest idea meanwhile is that conditions in the hot maelstrom of matter surrounding a black hole may be ideal for synthesising new elements Research scientists at the University of Chicago and the California Institute of Technology recently conducted a complex computer simulation programme to back up this theory

They even say some of the metals in the solar system may originate from the fusion 'oven' surrounding the black hole at the heart of the galaxy

Courtesy, *German News*

## Cancer Risk for High Fliers

Although scientists cannot assess precisely the long-term effects of low radiation doses, the report, issued by the U S. Government Department of Transportation states that people who fly a lot at high altitudes receive greater than expected doses of radiation from the sun and stars. Some radiation experts are cited in the report as recommending that women in the early stages of pregnancy avoid flying on the riskiest routes.

Radiation absorbed while flying differs according to latitude and altitude, increasing as an aircraft is nearer to the Poles. Concern about cosmic radiation has grown with the trend for aircraft to fly for longer and at higher altitudes, where the protective atmosphere is thinner.

Increasingly, aircraft flying between Europe and the United States pass over the North Pole, where the effect of the earth's magnetic field raises radiation levels to four times those at the Equator. The fastest aircraft, such as Concorde and corporate jets, are particularly vulnerable since they fly higher than others.

Experts advocate the installation of devices in cockpits that would advise pilots to drop altitude to avoid particularly high levels of high energy radiation. Such equipment would also alert pilots on the rare occasions when the sun's radiation, which varies considerably, reaches levels that the study says pregnant women flying only once should avoid.

Flying at 40,000 ft over the North Pole produces a radiation level of 1.4 millirems an hour, compared with 0.4 millirems an hour at the same altitude over the Equator. On the ground, where rocks and minerals emit radiation, the average level in New York is estimated at 0.0056 millirems an hour.

One medical scientist said that radiation levels absorbed by air passengers were sometimes as high as those that require warnings to workers in nuclear plants or other industrial jobs involving contact with X-rays and other radiation sources. As airlines are not covered by the Government Safety regulations that regulate employees' exposure, these levels are higher than those which most nuclear plant workers experience.

A U.S. Government study showed that airline staff run a similar health risk from radiation to that from cabins full of cigarette smoke, although working in the air heightens the risk of contracting cancer only moderately above the average.

About 22,000 Americans in 100,000 are expected to die of cancer. The study, on westbound flights, estimates that for airline staff who have flown 960 hours a year for 20 years on internal flights of at least three hours, the cancer death rate will be raised by 59 to 61 per 100,000. Passengers on the same routes, flying only half as many hours, are predicted to suffer 30 extra fatal cancer cases per 100,000.

Dr. Michael Ginevan, a scientist who compiled the statistics, said: "If I were a woman in the critical period of pregnancy for retardation (weeks 8 to 15), I would tend to avoid flights to Europe." He said that, since he completed the statistical work, new studies had revised the expected cancer rate for survivors of low radiation doses in Hiroshima and Nagasaki to double or triple the earlier expected rate.

Airline unions have expressed concern about exposure to radiation. But some scientists say that the average doses are too low to cause acute illness, even for frequent travellers on the riskiest routes.

## Discovery of a Lost Species

A long-lost tree-dwelling relative of humans and apes has been found in a leech-infested rain forest in Madagascar, an event described as one of the most important rediscoveries of mammals in a decade.

Mr Bernhard Meier, a biologist at Ruhr University in Bochum, West Germany, emerged from the forest with an injured knee, blood poisoning and malaria as well as the first photograph of the hairy-eared dwarf lemur, a tiny primate never before seen alive by scientists.

Five preserved specimens, the first collected 115 years ago, are held in museums, but until

Meier's discovery researchers had no idea whether the creature still existed.

The first complete description of the animal, known to scientists as *Allocebus trichotis*, will be published shortly in *Folia Primatologica*. Mr. Meier made the discovery last April, but it is only now being reported.

The lemur is born and shaped like a mouse, with a body five inches long and a seven-inch furry tail. It weighs no more than 99 grams.

"*Allocebus* is the smallest primate species in existence, except during the dry season when the mouse lemur is not fat and is smaller," Mr. Meier said in a telephone interview yesterday from his home.

The lemurs of Madagascar are scientifically important because they evolved in isolation during the millions of years that the other primates—monkeys, apes and humans—were evolving elsewhere.

"In effect, Madagascar is a giant experiment in alternative evolution."

The rediscovery is important because it is the only surviving species of an entire genus of lemurs that have disappeared, said Mr. Russell Mittermeir, President of Conservation International in Washington, and a primate specialist.

"If you lost a species, there are close relatives around," he said. "If you lost a genus, that's worse." "The discovery of the hairy-eared dwarf lemur is one of the two most important rediscoveries of mammals in a decade," Mr. Mittermeier said. The other was the rediscovery of the soft-spined porcupine in Brazil in 1966, he added.

"It is a little bit bizarre that this animal was discovered as early as 1875, and a scientist never saw this species alive." said Mr. Meier, who has a reputation among other wildlife biologists as a fearless explorer.

"I went three times to that forest to find that animal, although I already knew it was there," he said. An old man in a nearby village had told him about it.

To get to the forest, near Manara on the island country off south-east Africa, "you need to hike three days, long and strong," Mr. Meier said. "Nothing is dry after a few kilometres because you need to cross many rivers and creeks containing leeches "

## A Test-Tube Buffalo

There is a Murrah she-buffalo at the National Dairy Research Institute, Karnal serially numbered 2533 A casual onlooker will notice nothing unusual about her. A team of scientists in the National Dairy Research Institute, Karnal is waiting for the success in producing a Test Tube buffalo The she-buffalo is the recipient or 'surrogate mother' of what can he described as a 'test-tube buffalo'. She is about two months pregnant now (March, 1990) and in another seven months will give birth to what the institute's scientists claim will be the world's first reported case of a test-tube buffalo.

The NDRI team working on the project for nearly three years comprises Dr. M.L. Madan, Mr. B S. Prakash and Mr. J.D. Ambrose. Their achievement is being construed as a major breakthrough in the field of embryo transfer technology. It involves embryos successfully produced through *in vitro* maturation of oocytes (eggs), fertilization and culture of embryos. The prime advantage of the new technique is that through it the female can now produce many calves, albeit through the use of recipients or surrogates. According to team members, normally an animal can produce four or five calves during her reproductive life. But through the embryo transfer technique, figure can go up to 50 to 80. However, using the method of *in vitro* fertilization, the animal can produce more than 700 calves in her lifetime.

The oocytes are first gathered from buffalo ovaries and using laboratory techniques matured in a test-tube, so that they obtain the capacity to be fertilized. The mature oocytes are then *in vitro* fertilized, developed "through certain technological innovations" into full-fledged viable embryos, which are then transferred into recipient female buffaloes.

Dr. M.L. Madan said that while *in vitro* fertilization had been successful in cows, this had not been so in buffaloes, despite persistent efforts. *In vitro* fertilization among buffaloes holds promise because the experience of embryo transfer shows that superovulatory responses among buffaloes are poor when compared to cattle Attempts of *in vitro* fertilization and embryo transfer among buffaloes had shown development blocks in embryo formation beyond the 4-8 cell It is the overcoming of this barrier that the NDRI team has achieved successfully.

The team still insists on the secrecy of the technology used by it, not going beyond saying that it constitutes "modified composition of media and culture composition." It concedes though, that it has picked up the strings of earlier research in the field.

The success or the probability of getting a calf is expected to be between 35% and 50%, but this is only natural. The team has also developed a process of freezing embryos which can be revived when needed The team claims that this technique has made it possible to gather oocytes and produce embryos from animals that have lost their reproductive faculty or even from dead animals (In this case the oocytes are produced from dead animals in slaughter house ) Scientific details apart, the five-member team led by Dr Madan is waiting for September when Murrah 2533 gives birth to the world's first test-tube buffalo.

## Space Junk Databank for Aviation Safety

A databank of space junk is being formed to predict risks to spacecraft

Space debris is such material in the earth's orbit that cannot be described as an active spacecraft or instrument. At one extreme it comprises minute particles, invisible to the naked eye, that are the result of human activity in space. These include flakes of paint from spacecraft or tiny spheres of aluminium oxide produced by firing solid rocket motors in earth's orbit.

Though tiny and innocuous sounding, the impact of just one of these particles travelling at something like five km a second on a sensitive part of a communication satellite or manned mission could prove disastrous.

## New Surgical Technique: Auto-Transfusion

A new technique of surgery called Auto-Transfusion practised at the Neuro-Sciences Centre of the All Indian Institute of Medical Sciences, New Delhi for the past year and a half has proved very successful after being tried on 82 patients at the Centre.

In this new technique, units of blood are collected from the patients at periodic intervals before the operation. At the time of surgery the blood collected in this manner is transfused into the patient.

Dr. A.K Bannerjee, Head of the Neuro-Sciences Centre, says, "30 patients are on the waiting list." Talking to reporters Dr Bannerjee said, "Auto-transfusion is possible only in those cases when the patients can wait. Up to four units of blood of a patient can be collected within 30 to 35 days Surgery can be done only three days after the last collection of blood "

Gradually, he expected to be in a position to collect up to seven units of blood before a patient is operated upon.

Auto-transfusion popularity stems from the fact that this technique, to a great extent, eliminates the risk of common blood transfusion infections like hepatitis and AIDS. Some of the cases successfully operated so far include removal of large brain tumors Even in the Western countries, he said, this technique was very popular specially in the high-risk areas. The technique is economical, and blood groups need not be tested as there is no need for a cross match. The technique also does not produce any hypersensitive reactions.

Spurred by the success of the technique, the blood bank of AIIMS is now toying with the idea of introducing it in other areas too. The main bottleneck regarding such surgeries is the widespread scepticism prevalent among the patients, who are not keen about re-transfusion of their own blood. Thus, while the first auto-transfusion was performed in AIIMS in December 1987, it took another seven months to convince the next patient about the feasibility of this technique.

This novel method of surgery, according to Dr Bannerjee, should be given more publicity in order to convince people that the technique was not at all risky, and the chances of success were quite high.

# BOOK REVIEW

## Science Teasers

Edited by Dilip M. Salvi and published by Konark Publishers Pvt. Ltd., Delhi 110 092 (1989)

Today we are living in a world of 'science and technology', developing at a fast pace. The school-going students have to pick up a lot more than what science textbooks provide, if they desire to be well informed citizens of tomorrow. So a large number of students look for sources that can provide them the latest information about the interesting developments in science and technology, about which they get to know somewhat on the radio, television and from educated elders. Some of the sources tapped by the senior students of the schools having libraries are the encyclopedia and journals covering science and technology. But such schools are not many. Moreover the younger students between the age group 8 to 14, look for illustrated magazines and well-conceived books that can motivate them to pick up facts and information about science and technology. It is still better if the book also tests their knowledge. The hard fact is that there has been a dearth of such books in India.

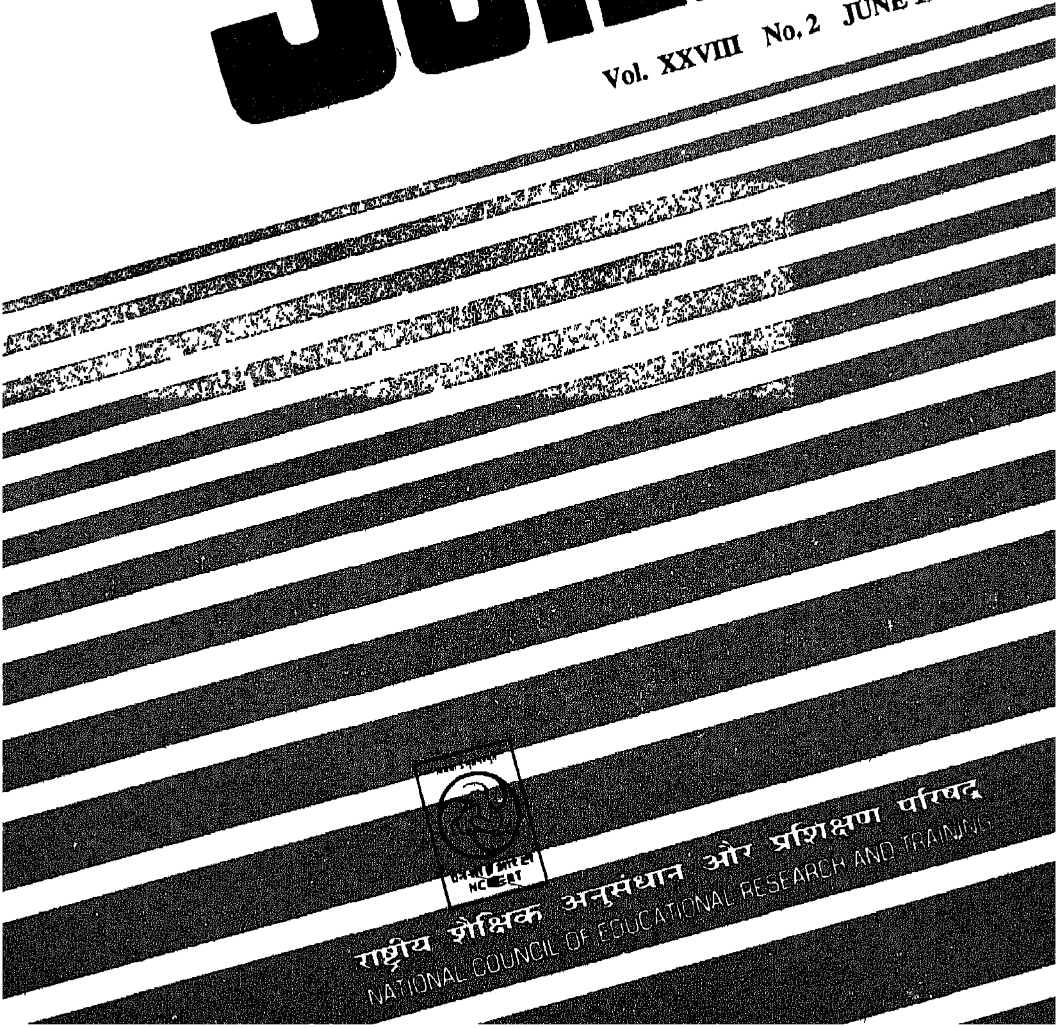
*Science Teasers* is certainly a well-prepared book that serves the purpose of motivating young students to build up informally their knowledge about interesting things related to science and technology. It also helps them test their knowledge and thereby gain confidence. It provides 108 well-designed teasers covering a large panorama of topics related to science and technology of interest to the students of age group 8-18. The book would interest even the parents having new interest in science and technology. This book is rather costly. But looking at its rich contents, printing, illustrations, and durable binding it can be afforded by the school libraries.

There is yet another similar title by the same author, *More Science Teasers*, by the same publishers.

K.J. KHURANA
*DESM, NCERT*
*New Delhi*

# SCHOOL SCIENCE

Vol. XXVIII No. 2 JUNE 1990



राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

# Indian Educational Review

*A Quarterly Journal of Educational Research*

**Indian Educational** Review, being published by NCERT, is one of the top journals in the field of educational research in India. The journal has a balanced coverage, including articles on all aspects of education and different fields of educational research, with a definite bias for problems relating to Indian scientists.

**Indian Educational** Review contains articles, research notes, book reviews, Ph.D. theses, materials on new horizons and other feature articles. The areas covered by the journal include sociology of education, economics of education, philosophy and history of education, comparative education, educational technology, work-experience and vocationalization, science and humanities, teacher education, educational psychology and such other allied subjects which have relevance to the Indian situation.

Further details may be obtained from

General Editor
Indian Educational Review
Journals Cell, NCERT
Sri Aurobindo Marg, New Delhi 110 016

---

Published at the Journals Cell by the Secretary, National Council of Educational Research and Training, Sri Aurobindo Marg, New Delhi 110 016, laser typeset at Scribe Consultants, B4/30 Safdarjung Enclave, New Delhi 110 029 and printed at Supreme Offset Press, K-5 Malviya Nagar, New Delhi 110 017.

A QUARTERLY JOURNAL
OF SCIENCE EDUCATION

# SCHOOL SCIENCE

Vol. XXVIII No. 2
June 1990

## CONTENTS

| | | |
|---|---|---|
| Dynamics of the Moon's Motion Around the Sun | 1 | AVINASH W. JOSHI |
| A Study of Students' Misconceptions about Electricity | 8 | A.B. SAXENA |
| An Open-ended Approach for Presenting Textual Materials in Physics at the Secondary Stage | 16 | S.G. GANGOLI |
| Ecological Problems of Sunderbans Mangrove | 20 | P. SANYAL |
| Elementary Facts about Elementary Particles | 25 | LALIT KISHORE |
| Some Observations on the Anatomy of *Marsilea Minuta* Linn. Occurring in Jamshedpur | 27 | S.N. BASU |
| Mobile Satcoms for the Future | 32 | JOHN R. NORBURY |
| A Technical Effort of Biology Teaching: Hospital as an Aid | 38 | V.K. DIXIT |
| Operation of Union and Intersection on Sets | 41 | MARLOW EDIGER |
| Puzzle on Scientists | 46 | |
| Science News | 47 | |
| Book Review | 52 | |

## TO OUR CONTRIBUTORS

*School Science* invites articles from teachers, acquainting students with the recent developments in science and science methodology. The articles should be addressed to Executive Editor, Department of Education in Science and Mathematics, NCERT, Sri Aurobindo Marg, New Delhi 110 016.

# Dynamics of the Moon's Motion Around the Sun

AVINASH W. JOSHI
**Department of Physics**
**University of Poona**
**Pune 411 007**

*Some not-so-well-known aspects of the moon's motion with respect to the sun are discussed. These are the direction of its motion and the curvature of its path*

*The article is based on the forthcoming book "Our Solar System", by A.W. Joshi and N.C Rana, to be published by Wiley Eastern Ltd, New Delhi.*

In this article, I wish to draw the reader's attention to a couple of small but important aspects concerning the motion of the moon. We say that the moon revolves around the earth and the earth revolves around the sun.

How would the motion of the moon appear as seen from the sun?

We would consider two aspects of the above question, (1) the direction of motion of the moon with respect to the sun, and (2) whether the path of the moon is convex towards the sun or concave towards it or a mixture of the two We will then generalize this to any satellite.

The earth revolves around the sun in an anticlockwise manner, as seen from the sun's north pole. The moon also revolves around the earth in the same sense as seen from the earth's north pole.

On a full moon day, the earth lies between the sun and the moon. The linear velocity vectors of both the earth and the moon are shown towards the left in Fig. 1 (anticlockwise). There is no

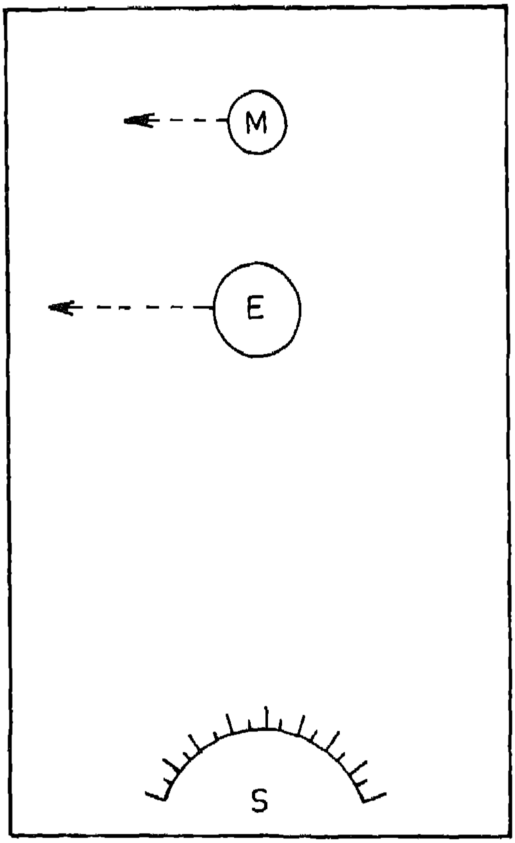


**Fig. 1.** *The sun S, the earth E and the moon M on a full moon day The direction of the instantaneous velocity of E and M is shown by the arrows.*

doubt that the moon's velocity *with respect to the sun* will also be in the same direction, and the path of the moon at his point will be *concave towards the sun.*

Consider now what happens on a new moon day, when the moon is between the sun and the earth. Fig 2 shows the situation. The velocity vector of the earth *with respect to the sun* points to the left while that of the moon *with respect to the earth* points to the right.

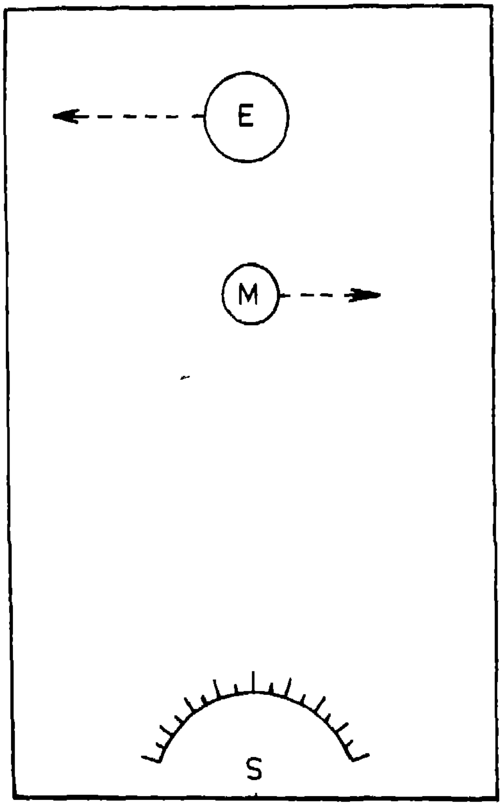


**Fig. 2.** *The sun S, the earth E and the moon M on a new moon day. The arrows show the direction of the instantaneous velocity of E with respect to S and of M with respect to E.*

## Sense of Rotation Around the Sun

I come to the first question. What will be the direction of motion of the moon on a new moon day with respect to the sun? Will it be clockwise as in Fig. 2 or anticlockwise?

For this, let us calculate the orbital velocities of the earth around the sun and the moon around the earth. If $r$ is the radius of the orbit of a planet/satellite and $T$ the time period for a revolution, the average orbital speed $v$ of the body in the orbit is given by

$$v = 2\pi r/T. \qquad (1)$$

For the earth, the values are

$$r = 1.496 \times 10^8 \text{ km}, \quad T = 365\,25 \text{ days}. \qquad (2)$$

Using these, we get the orbital speed of the earth around the sun to be

$$v_E = 29.8 \text{ km/s}. \qquad (3)$$

Using the values for the moon's revolution around the earth,

$$r = 3.84 \times 10^5 \text{ km}, \quad T = 27.3 \text{ days}, \qquad (4)$$

we get for the moon's orbital speed with respect to the earth

$$v_M = 1\,02 \text{ km/s}. \qquad (5)$$

As seen from the sun, the speed of the moon on a new moon day (Fig. 2) would be

$$29.8 \text{ km/s} - 1.02 \text{ km/s} = 28.8 \text{ km/s}, \qquad (6)$$

whereas on a full moon day (Fig. 1), it would be

$$29.8 \text{ km/s} + 1.02 \text{ km/s} = 30.8 \text{ km/s} \qquad (7)$$

Thus even on a new moon day, the moon would move in an *anticlockwise* manner with respect to the sun. As seen from the sun, the speed of the moon would vary from about 28 8 km/s to 30.8 km/s, but would always be in the same sense.

Thus a diagram like Fig. 2 is *highly misleading*. In one and the same diagram, we have shown the motion of two bodies with respect to two *different frames of reference*! Such diagrams should *not* be drawn

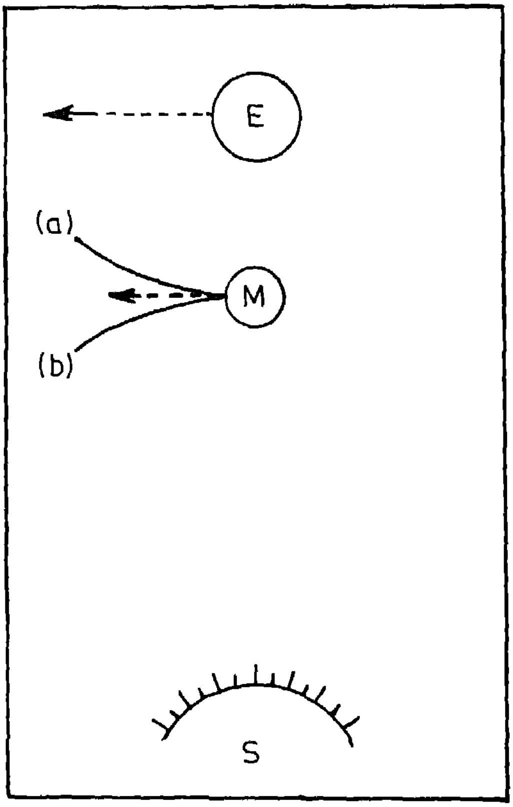


**Fig. 3.** *The same configuration as Fig. 2 on a new moon day, but the arrow on M now shows the direction of its velocity with respect to S. Path (a) is convex towards the sun; path (b) is concave towards it.*

### Concave or Convex Orbit?

Now I come to the second question. The orbital path of the moon, as seen from the earth is *concave* towards the earth at every point of its path. Similarly the orbital path of the earth, as seen from the sun, is *concave* towards the sun at every point on its orbit.

How is the path of the moon as seen from the sun?

Fig. 3 again shows the sun-earth-moon system on a new moon day. As we have seen earlier, the instantaneous velocity vector of the moon is to the left (anticlockwise). Now for the actual path of the moon with respect to the sun, there are two alternatives shown in Fig. 3: (a) convex towards the sun, and (b) concave towards the sun.

How shall we decide the correct path, as seen from the sun?

Whether the moon will take a path like (a) or (b) will depend on the direction of the net force acting on the moon. The main forces acting on the moon are the gravitational forces due to the earth and the sun. The forces due to other planets on the moon are quite negligible.

If the net force on the moon is towards the earth, the moon will follow a path like (a) and if it is towards the sun, it will take a path like (b).

The gravitational force of one body on another is given by

$$F = GMm/d^2, \tag{8}$$

where $G$ is the universal constant of gravitation, $M$ and $m$ are the masses of the two bodies and $d$ is the distance between them.

We wish to compare the forces acting on the moon due to the sun and the earth. The average sun-moon distance on a new moon day is

$$1.496 \times 10^8 \text{ km} - 384000 \text{ km}$$
$$= 1.492 \times 10^8 \text{ km} \tag{9}$$

and the mass of the sun is $2 \times 10^{30}$ kg. The mass of the earth is $5.97 \times 10^{24}$ kg. Therefore the ratio of the two forces is

$$\frac{2\times 10^{30}\,\text{kg}}{(1.492\times 10^{8}\,\text{km})^2}\cdot\frac{(384000\,\text{km})^2}{5.97\times 10^{24}\,\text{kg}} = 2.2. \quad (10)$$

Thus the force due to the sun on the moon is 2.2 times that due to the earth. Here we have used the average sun-earth and earth-moon distances Even if we take the shorter earth-moon distance (356000 km) and the longest sun-earth ($1.52\times 10^{8}$ km, the above ratio comes out to be 1.84, which is well above 1.00

The essential point is that the force exerted by the sun on the moon at the new moon configuration is greater than that exerted by the earth This will, in fact, be the case at every point on the path of the moon. The result is that the instantaneous acceleration of the moon at every point on its path has a positive component towards the sun

The conclusion is obvious· The path of the moon with respect to the sun is *concave* towards the sun at every instant.

## Explanation of Relative Motion

If the moon's path is concave towards the sun t every point of its path, how does it appear to s to be going around the sun?

The explanation is simple and it lies in the lative motion. Fig. 4 shows the earth and the oon on a new moon day, at $E_1$ and $M_1$, respectively. We now consider their motions in a short time-interval, say one hour.

Since the earth's speed is 29.8 km/s with respect to the sun, it would move 107280 km in an hour, to point $E_2$.

If the earth and the moon were connected to the sun by a rigid rod, the moon would have come to point $A$ in the same period. Noting the sun-earth and the sun-moon distances given above in Eq. (9), one can see that the distance $M_1A$ would be 106993 km.

But they are not connected by a rigid rod The moon's speed relative to the sun on a new moon day is 28.8 km/s as seen in Eq (6). Thus in one hour, the moon would travel 103680 km relative to the sun and would be at the point $M_2$ in Fig 4. As seen from the earth, it appears as if the moon is revolving around it in the *anticlockwise* manner

However, note that this need not be the case with every satellite in the solar system. For example, a satellite of Jupiter will experience a larger force from Jupiter than from the sun (due to the large sun-Jupiter distance and the large mass of Jupiter) Therefore its path, as viewed from the sun, may occasionally be convex towards the sun This will also be the case with an

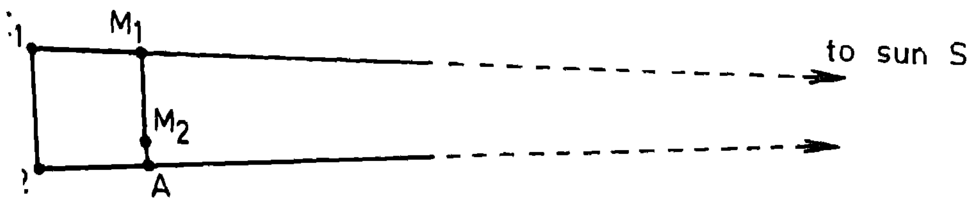


Fig. 4. *The motion of the earth and the moon relative to the sun in a short time interval*

artificial satellite of the earth. This is shown below with some simple calculation.

## General Considerations

The point between the sun and the earth at which the forces due to these two bodies are equal to each other occurs at a distance of about 258000 km from the earth's centre. Hence if the earth has a satellite at a distance less than this, the earth would exert a stronger force on it than the sun.

Consider an (artificial) satellite around the earth at a distance smaller than the above critical distance. In that case, it is clear that the force on it due to the earth would have a larger magnitude than that due to the sun

Let us make a model calculation for simplicity. Let us assume that the satellite goes around the earth in a circular orbit of radius less than the above critical value, and also that the sun-earth line lies in the plane of this orbit

Let us denote by $\mathbf{F}_E$ the force on the satellite due to the earth and $\mathbf{F}_S$ that due to the sun. Let the ratio of their magnitude be $p$, so that

$$\mathbf{F}_E = p\mathbf{F}_S \tag{11}$$

For a satellite distance smaller than 258000 km, $p > 1$, while for a distance greater than this value $p < 1$.

We have shown in Fig. 5 a satellite going around the earth. $A$ and $B$ show two positions of the satellite in its orbit. The angle $AES$, denoted by $\theta$, is a variable. The force $\mathbf{F}_E$ is directed towards $E$. For the satellite distance less than 258000 km, the ratio of the earth-sun distance to the earth-satellite distance is greater than 580

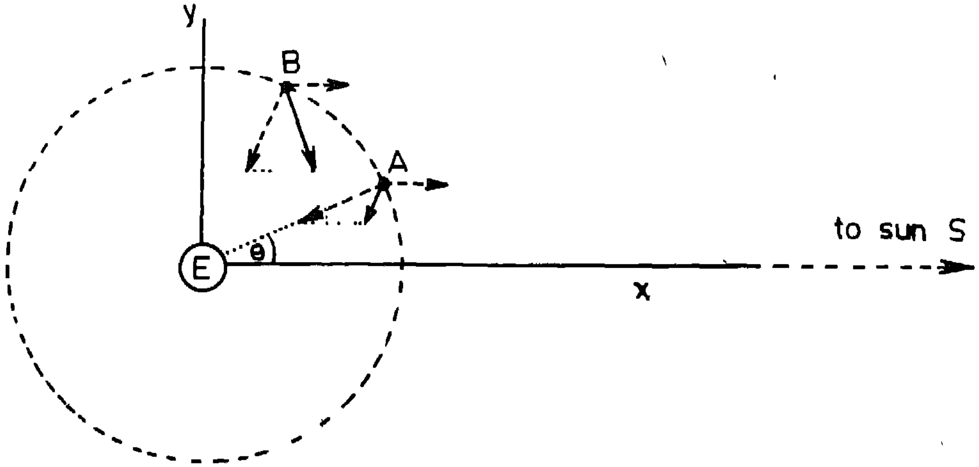


Fig. 5. *A satellite going around the earth E. The forces acting on it due to the earth and the sun S (dotted arrows) and their resultant (solid arrow) are shown for two positions of the satellite*

Therefore the force $\mathbf{F}_S$ can be assumed to be parallel to the line $ES$, pointing towards the sun $S$

We take a coordinate system with $E$ as origin, $x$ axis along $ES$ and $y$ axis normal to it. Let $\hat{\mathbf{x}}$ and $\hat{\mathbf{y}}$ be unit vectors along the Cartesian axes, respectively. Then, for any position of the satellite, we can write the forces acting on it as

$$\mathbf{F}_E = -\hat{\mathbf{x}}\mathbf{F}_E\cos\theta - \hat{\mathbf{y}}\mathbf{F}_E\sin\theta, \qquad (12)$$

$$\mathbf{F}_S = \mathbf{F}_S\hat{\mathbf{x}}. \qquad (13)$$

The resultant force on the satellite is then

$$\begin{aligned}\mathbf{F}_R &= \mathbf{F}_E + \mathbf{F}_S\\ &= (\mathbf{F}_S - \mathbf{F}_E\cos\theta)\hat{\mathbf{x}} - \hat{\mathbf{y}}\mathbf{F}_E\sin\theta. \qquad (14)\end{aligned}$$

We now ask the questions: For which parts of the orbit does the resultant force have a positive (negative) component towards the sun? For which value of angle $\theta$ does the $x$-component of the resultant force vanish?

Both the questions can be easily answered by looking at Eq. (14). If $\alpha$ is the value of $\theta$ for which the $x$-component of $\mathbf{F}_R$ vanishes, then from Eqs. (14) and (11), we have

$$\mathbf{F}_S = \mathbf{F}_E\cos\alpha = p\mathbf{F}_S\cos\alpha. \qquad (15)$$

Hence $\alpha$ is given by

$$\cos\alpha = 1/p. \qquad (16)$$

Fig. 6 shows the situation when $\theta = \alpha$, the satellite is at point $C$ in its orbit, and the resultant force is directed towards the negative $y$ axis. A symmetrical position also occurs at point $D$ because $\theta = -\alpha$ also satisfies Eq. (16).

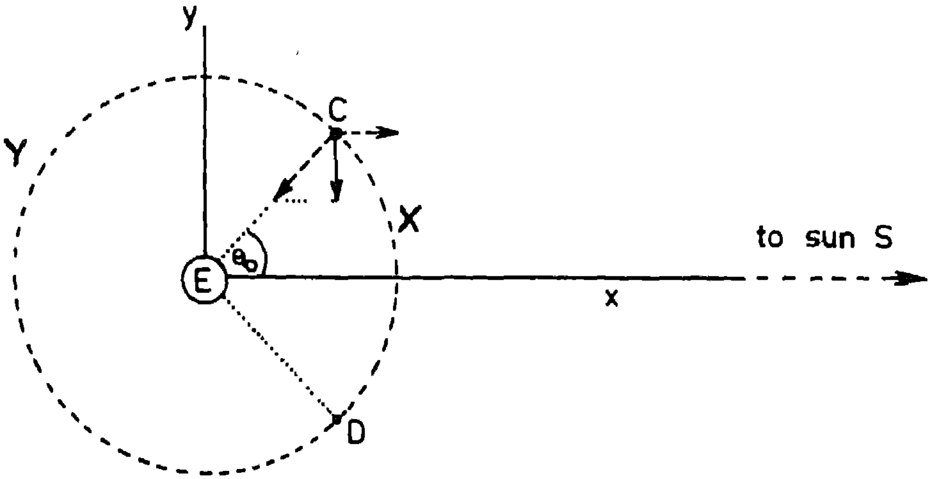


**Fig. 6.** *At positions C and D on the orbit, the x-component of the resultant force on the satellite vanishes.*

The following conclusions can be easily drawn on the basis of the above calculations.

(a) When the satellite is in the portion $CYD'$ of its orbit, the resultant force on it has a positive component towards the sun; the path of the satellite would be *concave* with respect to the sun

(b) When the satellite is in the portion $DXC$ of its orbit, the resultant force on it has a negative component towards the sun; the path of the satellite would be *convex* with respect to the sun.

Note that for $p < 1$, Eq. (16) has no solution. This corresponds to the fact that when the sun's pull on the satellite is larger than the earth's pull, the orbit of the satellite relative to the sun is always concave towards it.

# A Study of Students' Misconceptions about Electricity

A.B. SAXENA
**Regional College of Education**
**Bhopal 462 013**

---

*There appears to be sufficient evidence that there are number of misconceptions related to electricity and its nature among undergraduate students who were examined. This is despite their education in physics over a number of years.*

---

A large number of studies have been conducted all over the globe to identify the students' misconceptions related to physics during the last couple of years. Some excellent publications (e.g., McDermott 1984, Gilbert and Watts 1983, Driver and Erickson 1983, Novak 1987) have discussed the work done in this direction. However, the research studies have been dominated in the area of mechanics (Moreira and Dominguez 1987). Limited attention has been paid to explore the misconceptions in the area of electricity (e.g., Joshua 1984, Moreira and Dominguez 1987, Shipstone 1984, Solomon 1985). In this study, an attempt has been made to identify misconceptions related to electricity among undergraduate college students in India that have physics as major subject To the knowledge of the author, no study in India has been reported in this area.

Shipstone (1988) has reviewed the studies related to electricity carried out under the paradigm of constructivist psychology which considers human beings as prototypical scientists, constructing hypotheses and testing these against experiences in order to understand the world around him Shipstone (1988) has described various models of electricity such as 'consumer model', attenuation model and 'sequence model'. Joshua (1984) has reported the variety of students' interpretation of a series of simple diagrams. He concludes that notion of potential and potential difference is rarely introduced to explain circuit diagrams. They interpret diagrams as "figurative representations of a 'system of pipes' through which the passage of current (as a fluid) can take place". Shipstone (1984) examines the models of flow of current used by children to explain electrical circuits containing fixed and/or variable resistors connected in series or parallel. He uses paper and pencil test consisting of ten questions and analyses the pupils responses in the context of four models of current It is found that pupils use erroneous model of current flow and due to this, many electrical principles cannot be assimilated Analysing the pupils free writing on electricity, Solomon (1985) finds that after learning simple circuits using acceptable model of current pupils are not able to transfer this ability to explain the circuit of simple instruments such as torch and bicycle dynamo.

Moreira and Dominguez (1987) go one step further and observe the effect of instructions on the existing misconceptions and conclude that learner's misconceptions and related cognitive structure are stable so as to be little affected by the instructions used by him.

### Plan of Study

Regional College of Education, Bhopal has four-year B.Sc./B.Ed. course integrating the physics/chemistry/mathematics content with 'education'. This study explores and identifies the existing misconceptions among students who take up this course at different stages. These stages are distinguished by years and described as Part I to Part IV It is a co-educational course, dominated by girls The students admitted to the course come from mainly the States of Madhya Pradesh and Maharashtra. The age group of the students ranges between 17 years to 21 years All the students attending the course and available on the days of study were included. No choice was made. However, for the purpose of analysis, the sex was ignored. Table 1 shows the details of the students included in the study.

Paper-and-pencil test consisting of ten questions was used in the study. Each question was of multiple choice type having three to four choices. One question turned out to be inappropriate and hence was left out for analysis and reporting. Each question, apart from having multiple possible answers, had also blank space and students were specifically instructed to justify the choice made by writing it in the blank space. The questions are described in the text of the paper while discussing the responses. They are based on six concepts: resistors in series and parallel, current, Ohm's law, Joule's law of heating, Coulomb's law and charging by rubbing. All these concepts are dealt with in the senior secondary curriculum, which is qualifying course for B.Sc./B.Ed. It also has experiments based on electricity. They had further physics education in B.Sc./B.Ed course depending upon the stage they were in

The justification given by students was particularly taken care of while identifying the misconceptions This method has been used successfully earlier also (e g., Shipstone 1984, Saxena 1990). However, for the purpose of clarification and further understanding of the students' conception, 12 students, both boys and girls, were further interviewed on the basis of responses they had written earlier. This was tape recorded and referred to when required during analysis.

### Analysis of the Responses

**Q. 1.** Fig. 1 shows two resistors $r_1$ and $r_2$ connected to a cell. What is the resistance between points $A$ and $B$?

i. more than $r_1$ and $r_2$ individually

ii. more than $r_1 + r_2$

iii. between $r_1$ and $r_2$

iv.* less than $r_1$ and $r_2$ individually

Reason** __________

* Correct response is marked * for the purpose of this paper

** Similarly space was provided with each question. This shall be omitted henceforth

**TABLE 1**
**Details of Students Included in the Study**

| *Group* | *Stage of Course* | *No. of Students* | *M/F* |
|---|---|---|---|
| Group 1 | B.Sc./B.Ed. I | 46 | 13/33 |
| Group 2 | B.Sc./B.Ed. II | 25 | 5/20 |
| Group 3 | B.Sc./B.Ed. IV | 34 | 6/28 |
| | Total | 105 | 24/81 |

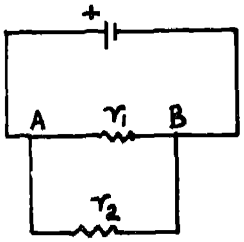


Fig. 1

Table 2 shows the percentage of students who opted for correct responses. It also shows that much small percentage could support it with correct reasoning. Most of the students only mentioned of the relevant formula but failed to either derive the correct meaning from it or give its physical interpretation.

Q. 2. A circuit consisting of two coils $r_1$ and $r_2$ is shown in Fig. 2. The current is

i.* equal at points $A$, $B$ and $C$.
ii. highest at point $A$ and lowest at point $C$.
iii. highest at point $C$ and lowest at point $A$.
iv. highest at point $B$ and lower at points $A$ and $C$.

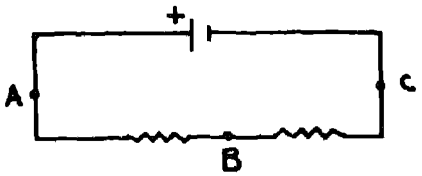


Fig. 2

**TABLE 2**
**Percentage of Correct Responses in Each Group for Various Questions. Number in Bracket Shows the Percentage of Correct Responses that are also Supported by Correct Reasoning**

| | *Group 1* | *Group 2* | *Group 3* |
|---|---|---|---|
| Question 1 | 61 (44) | 56 (8) | 55 (32) |
| Question 2 | 33 (24) | 44 (24) | 35 (27) |
| Question 3 | 67 (46) | 32 (20) | 74 (71) |
| Question 4 | 46 (22) | 48 (20) | 32 (15) |
| Question 5 | 41 (15) | 52 (24) | 50 (24) |
| Question 6 | 15 (4) | 36 (16) | 50 (21) |
| Question 7 | 26 (20) | 16 (8) | 29 (11) |
| Question 8 | 52 (18) | 36 (28) | 47 (41) |
| Question 9 | 61 (30) | 68 (32) | 61 (44) |

Only about one-fourth in each group could choose the correct response and also give correct reasoning Another important feature was that a large fraction, 37%, 44% and 65% respectively, stated that the current was highest at *A* and lowest at *C* More than half of them ascribed this to some characteristic related to resistance such as 'consumed', 'reduced':

> 'it (current) has to pass through two resistances and the current is lower at *C*'
>
> 'because some of the current is reduced to overcome the resistance'
>
> 'because the coils apply resistance, so some amount of current is consumed to overcome resistance'
>
> 'since current is inversely proportional to resistance'

When asked to elaborate the point, students used variety of terms as 'used up', 'flow of current will be reduced', 'current is blocked', 'some current will be absorbed'. This is in consonance with attenuation model of electricity where current is regarded as travelling round the circuit in one direction only, with more leaving one terminal of the battery than returns to the other (Shipstone 1988).

Moreover, we did not find any argument for constant flow of current on the basis of conservation of charge. Most of the students seem to think in terms of flow of fluid that is conserved or consumed, though most of these were aware of current as flow of electrons (Q. 3).

Q. 3. In Fig 2 a circuit is shown. Which of the following statements is true about flow of charge?

i. electrons flow from *A* to *B* to *C*.
ii. protons flow from *A* to *B* to *C*.
iii.* electrons flow from *C* to *B* to *A*.
iv. protons flow from *C* to *B* to *A*.

For this question, the percentage of correct responses is highest in two groups, 1 and 3 About two-third of the correct responding students are able to support this by correct reasoning. The most prominent but wrong choice is 'electrons flow from *A* to *B* to *C*'. In three groups its percentage respectively is 30, 48 and 27. The reasonings are like:

> 'current flows from positive electrode to negative electrode and flow of electrons is known as current'
>
> 'because current is flowing from *C* to *B* to *A*'
>
> 'because electricity is flow of electrons'

These views were further corroborated during the interview.

Q. 4. Five wires of equal length and diameter but of different materials are connected in turn between two points maintained at constant potential difference. The heat developed in the wires is .

i. at the same rate in all the wires.
ii. highest in the wires of highest resistance.
iii.* least in the wire of highest resistance

It is important to remind that students were conversant with Ohm's law. Yet, less than 50% in each group chose the correct alternative and about 20% could give the correct reasoning Students tend to think at intuitive level that more resistance would generate more heat (48%, 36% and 53% respectively). There seems to be some relationship between this argument and reduction of current with flow through resistors (Q. 2). The argument met during interview is like:

> 'highest resistance means it allows less current to pass It blocks current. Due to conservation of energy, it will be converted to heat'
>
> 'more and more current energy will be converted in other forms (due to more resistance)'

Here students talk of current as energy, which gets reduced as current passes through resistance. Analysis showed that at least 15% in each group opted for both Q. 2 (ii) and Q. 4 (ii).

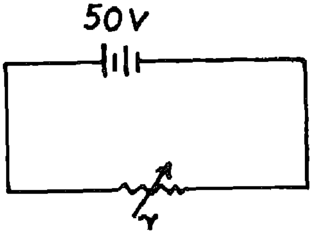


Fig. 3

**Q. 5.** A Heating coil of resistance *r* ohm (Fig. 3) is connected to 50 V battery of negligible internal resistance. If the resistance of the coil is reduced to *r*/2 ohm, the heat produced per second will be

i. reduced

ii. same

iii.* increased

The logic used to arrive at the right answer in questions 4 and 5 is the same. This is reflected in approximately equal percentage of right responses in two groups. It is also seen that students are also common that give right responses for the two questions. However, in group three there seems to be some wavering students that are responsible for difference of percentage in the case of group 3. It is also seen that almost all the students that opt for 'reduced' heat produced in question 5 also have the opinion that higher resistance would result into more heat produced in question 4.

**Q. 6.** In a conduction tube $6.25 \times 10^{18}$ electrons flow per second constituting 1 A current. In another tube protons are flowing constituting 1 A current. The number of protons flowing per second will be

i more than $6.25 \times 10^{18}$

ii * equal to $6.25 \times 10^{18}$

iii. less than $6.25 \times 10^{18}$

iv. protons cannot constitute current.

Though right answer of this question is obvious, but it is experienced that this question posed considerable difficulty to the students This could be seen in the low percentage of right responses. A large number of students 72%, 48% and 24%, seem to think that flow of protons cannot constitute current This is also corroborated from the fact that only 4% students in total state proton as flow of current in question 3.

Two common misconceptions are found here. The wrong reasoning that is prevalent with correct response is equality of number of electrons and protons in an atom or substance and not equality of charge of electron and proton. The second misconception is that due to 'mass of proton is more than electron' the number of protons will be 'less than $6.25 \times 10^{18}$'

**Q. 7.** A glass rod is rubbed with a silk cloth and it acquires positive charge. This happens because,

i. positive charges are produced on the glass rod

ii. positive and negative charges are produced and negative charges removed

iii.* negative charges are not produced, but removed only.

This question proved to be toughest in the sense that it received minimum number of correct responses. The two wrong responses received comparable attention from the students as can be seen from the following:

| | Option (i) | Option (ii) |
|---|---|---|
| Group 1 | 26% | 44% |
| Group 2 | 32% | 44% |
| Group 3 | 24% | 38% |

During the interview, students revealed variety of hypotheses, such as:

1 An ordinary material does not contain charges.
2 When we rub silk with glass new charges are produced
3. Ordinary material contains neutral charges (What does it mean?).

While discussing this many students were found to be vacillating and retrograding from scientifically acceptable concept to misconception.

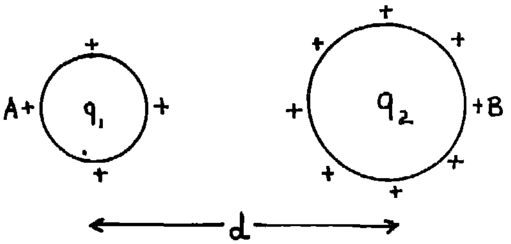


Fig. 4

Q. 8. Fig 4 shows two metallic spheres at a distance $d$ having charges $q_1$ and $q_2$ ($q_1 \neq q_2$). What about forces acting on them due to charges?

i. Force on sphere $A$ is greater than on sphere $B$
ii. Force on sphere $B$ is greater than on sphere $A$.
iii.* Force on spheres $A$ and $B$ is equal.
iv. Force on spheres $A$ and $B$ depends on if $q_1$ or $q_2$ is greater.

The correct answer of this question could be found using Newton's third law. However, around half of the students (46%, 60% and 50%) opined that force on sphere $A/B$ will have greater/smaller force depending upon $q_1/q_2$ is greater or smaller. The reasoning given is like this

> 'force is directly proportional to charge and inversely proportional to square of distance'
>
> 'because it is given that $q_1 \neq q_2$
>
> 'force depends upon charge'

In some cases, students are found to know the correct formula to calculate the resultant force but cannot interpret it correctly in the context of the question.

Q. 9. Fig. 5 shows three circuits with one bulb each. The battery in all the three circuits is identical and hence its potential difference is not given The resistance of bulbs is shown in the figure Which bulb will glow brightest?

i.* Bulb 5 Ω
ii. Bulb 15 Ω
iii. All bulbs will have the same brightness

The correct reasoning in this question is the same as in Q. 4 and Q. 5, yet the number of students choosing correct response in this case is considerably higher. It is not clear if this is due

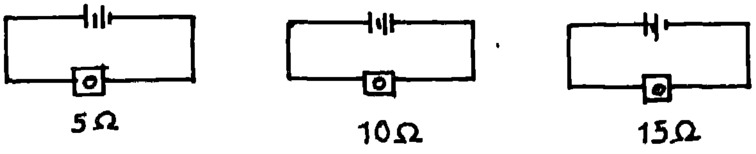


Fig. 5

to familiarity with the elements of Q 9 or due to some other reason The next popular choice is of 15 Ω bulb and most of the students that choose this mention its cause as highest resistance. This is the argument which we have encountered earlier also. The hypothesis of treating battery as constant current source (Shipstone 1984) is relevant in this context For, some students hinted that heat produced is $I^2R$ and thus heat is proportional to $R$. This requires to be explored further but it appears that some students treat battery as constant current source rather than constant potential difference source.

## Discussion

There appears to be sufficient evidence that there are number of misconceptions related to electricity and its nature among undergraduate students who were examined This is despite their education in physics over a number of years which includes conduction of experiments based on electricity.

The verification of Ohm's law, specific resistance by meter/Carey-Foster's bridge/post-office box, internal resistance of cell are some such experiments. How much deep and stable are these conceptions (Moreira and Dominguez 1987) need to be explored in the Indian context. The more common misconceptions that were encountered in this study are.

1 Current decreases as it passes through the resistors.
2 When current flows in a coil, the direction of flow of electrons is the same as that of the current.
3 Heat produced in a circuit is proportional to the resistance of the resistor.
4. Flow of protons does not constitute current
5 Charging a body by rubbing means production of charges.
6. The mutual force acting on two charged bodies is not equal

Though the existence of misconceptions related to electricity have been reported in the studies conducted in other countries also, in the Indian context there could be variety of reasons. These may include lack of opportunity on the part of teacher to examine and discuss students concepts Normally the examination consists of questions that are more or less based on information given in the textbooks. There is less scope for the inclusion of application-type questions. Large number of students in a class—around fifty—also leads to little opportunity to the teacher to develop individual contact with all the students.

## References

1 Driver, R and Erickson, G. (1983). "Theories-in-action. Some Theoretical and Empirical Issues in the Study of Students' Conceptual Framework in Science", *Studies in Science Education*, Vol. 10, pp. 37-60.

2. Gilbert, J.K and Watts, D.M. (1983). "Concepts, Misconceptions and Alternative Conceptions: Changing Perspectives in Science Education", *Studies in Science Education*, Vol. 10, pp. 61-99

3. Joshua, S. (1984). "Students' Interpretation of Simple Electrical Diagrams", *Eur J Sc. Educ.*, Vol. 6 (3) pp. 271-75.

4. McDermott, L.C. (1984). "Research on Conceptual Understanding in Mechanics", *Physics Today*, Vol. 37, pp. 24-32.

5 Moreira, M.A. and Dominguez, M.E., (1987), "Misconceptions in Electricity among College Students", *Ciencia e Culture*, Vol. 39 (10), pp. 955-61.

6 Novak, J.D. (Ed.) (1987). *Proceedings of the Second International Seminar: Misconceptions and Education Strategies in Science and Mathematics*, July 26-29, 1987, Cornell University, Ithaca, Vol. 3.

7. Saxena, A B. (1990). "Understanding the Properties of Light by Students of India". Communicated to *International J. of Sci. Education*.

8 Shipstone, D.M. (1984). "A Study of Children's Understanding of Electricity in Simple D.C. Circuits", *Eur. J. of Science Education*, Vol. 6 (2), pp. 185-98.

9. Shipstone, D. (1988). "Pupils' Understanding of Electrical Circuits", *Phys. Educ.*, Vol. 23, pp. 92-96.

10. Solomon, J. (1985). "The Pupil's View of Electricity", *Eur. J Sc. Educ.*, Vol. 7 (3) pp. 281-94.

# An Open-ended Approach for Presenting Textual Materials in Physics at the Secondary Stage

S.G. GANGOLI
Regional College of Education (NCERT)
Mysore 570 006

*In studying the reference materials by themselves the students will not only feel satisfied and have a sense of achievement but will also gain confidence and develop their ability to learn*

## Introduction

Many factors have to be carefully considered while developing textual materials. Constitutional imperatives, socio-cultural considerations, pedagogic concerns, feasibility are only some of them. Once the content topics are broadly selected after considering these factors the problem is that of its presentation Many academic challenges and economic restraints pose problems while presenting the textual materials. To start with we have the challenge of knowledge explosion In the limited time available can all important concepts and their applications be developed in the school books? Next, the problem is of finding an optimum way of meeting the demands of average students and that of talented students If the books are to be written for the latter, much of it will become unnecessary from the point of view of average students and hence colossal waste of resources. Then there is the challenge of fulfilling the cherished objectives such as, familiarizing the students with the processes of science, developing the ability of learning to learn, etc. Keeping these challenges in view an open-ended approach of developing learning materials in textbooks is suggested and its salient features are discussed below.

## Format

The format of this approach is similar to the one developed by us for the open-ended experiments in science (1976, Rais Ahmed and Gangoli). In essence it is a guided discovery approach, which is child-centred.

By open-ended approach is meant an approach in which the students have some freedom to choose the details of what they want to learn, and they can learn in the way they think best (1976, Gangoli). They can learn more and more and there is no end to what they can learn.

## Salient Features of the Format

1. Introduction to the topic
2. List of instructional objectives
3. Development of the learning materials
4. Reference activities
5. Test items

This format is illustrated below for the chapter on sound.

**I. Introduction:** The introductory note is meant to recall their previous knowledge on sound, to raise their curiosity and to indicate what the chapter contains.

One can recall one's experiences involving speech, echo, noise, music, musical instruments, etc. This will be similar to what is found in most books on this topic. However, after the introductory note whereas most books present learning activities to develop the different concepts, in this approach, instructional objectives in specific behavioural terms will be listed

**II. Instructional Objectives**

1. To recognize that sound is produced by vibrating bodies
2 To verify that a material medium is necessary for the propagation of sound
3 To recall the relationship between speed, wavelength and frequency of sound waves.
4. To recognise that propagation of sound is different in different media
5. To compare the speed of sound with that of light
6. To verify that speed of sound is different in different media.
7 To relate speed of sound with the physical properties of the medium
8. To illustrate how sound is detected.
9. To discriminate between intensity of sound and loudness of sound
10 To discriminate between noise and music.
11 To discriminate between a beat and a note.
12. To cite examples involving phenomenon of resonance.
13. To generalise that resonance is produced when impressed frequency is equal to the natural frequency of the vibrating body
14. To see the relationship between the frequency, tension, length and density of a vibrating string
15 To infer the speed of sound by resonance column method
16 To generalise how musical instruments produce sound
17. To see the relationship between the length of a flute and the wavelength of sound
18 To recognise that pitch changes due to relative motion between the source and the observer
19 To define ultrasonics
20 To generalise that ultrasonics can be used to measure the distances of objects under water

**III. Development of the Learning Materials:** From the above list of objectives those objectives which we think as basic and learning materials for which should be discussed in the textbook, are first selected Let us call them as core objectives Then we will select objectives which an average student can achieve by self-study Lastly, we are left with objectives which we think that an average student at the Class X level need not know but which may interest students who are above average Let us call them self-study objectives for the bright students

From the above list, the consensus may be that objective 1, 2, 3, 7, 8, 9, 10, 12, 13, 14, 16 and 19 be grouped as core objectives Suitable learning materials following discovery approach will be developed and discussed in the textbook. The remaining objectives are meant for self-study. The students are supposed to learn them They may ask others, refer to books and do any suitable activity. However, in order to facilitate their study and to ensure that they do not spend their time in unrewarding activities, we expect them to limit their activities which will enable them to answer the questions listed in the textbook

## Self-study Objectives

In the above list, objectives numbered 4, 5, 17, 18 and 20 are for self-study by all the students. For example, consider objective No. 4, "To recognise that propagation of sound is different in different media " If students can find answers for the following questions they will achieve what is expected from them.

4 (i) Do you notice any change in the loudness of the sound produced by a distant body say a train's whistle, during different seasons of the year? Give possible reasons.

4 (ii) Why is that some people put their ears to the road to find out whether a bus is approaching or not?

As another illustration consider objective No. 20, "To generalise that ultrasonics can be used to measure the distance of objects under water." Students should find answers for the following questions:

1. When do you hear an echo?
2. If the speed of sound in air is 330 metres per second, what is the time interval between the production of sound and hearing of an echo from a wall at a distance of 200m?
3. Why is it that ultrasonic waves can travel a longer distance in water in comparison to audible sound waves?
4. If the signal reflected from the submarine be picked up by a detector kept near the signal generator, after $t$ seconds, calculate the distance of the submarine, assuming the speed of ultrasonics in water
5. How would you measure the distance of a shoal of fish or a hidden treasure under water?

The above questions are such that even an average student can find the answers, with the help of teachers and others Next, consider self-study objectives numbered 6, 11, and 15 meant for the bright students.

Consider objective No 6, "To verify that speed of sound is different in different media."

Students should find answers for the following questions by self-study:

6 (i) How does one determine the speed of sound in air?

6 (ii) How does one determine the speed of sound in water?

6 (iii) How does one find the speed of sound in strings?

6 (iv) How does one find speed of sound in iron?

6 (v) Compare the speed of sound in gases, liquids and solids.

Lastly, we will consider evaluation material for objective number 15, "To determine the velocity of sound in air using resonance column method."

The students are expected to do the experiment in the laboratory using a tuning fork and a glass cylinder containing water. They will gradually decrease the water in the cylinder, using a stopper, till sound due to resonance is heard. Then they should find answers for the following at resonance conditions.

1. What is the relation between the frequency of the tuning fork and the frequency of the sound wave travelling in air?
2. What do you expect to have—a node or an antinode at the water surface in a resonance tube?
3. What is the relation between the distance of the water level from the tuning fork and the wave length of sound?
4. Knowing frequency and wave length, calculate the speed of sound in air.

**IV. Reference Activities:** Relevant books which are commonly available in the school library or with other students will be listed Class teachers may add other books. Audio-visual aids which are easily available or can be fabricated will be listed. Besides reference will also be made to experiences which can be easily had in the school laboratory or in the neighbourhood.

**V. Test Items:** Test items will be graded and listed in the end. They are primarily meant to find out whether the students have achieved the desired objectives or not.

## Discussion

As seen above, in the chapter on sound, though 20 objectives are listed, only 12 of them will be developed in detail. Of the remaining objectives five are to be achieved by all the students by self-study and three by only the bright ones. This has many advantages.

1. It will save considerable amount of time and money in producing textbooks.
2. The book can cater for both the average and the talented students at no extra cost.
3. In studying the reference materials by themselves the students will not only feel satisfied and have a sense of achievement but will also gain confidence and develop their ability to learn It has been found after a detailed investigation (1985, Gangoli and Gurumurthy) that by doing experiments by the open-ended approach rather than by the traditional approach students do better in achievement tests and skill tests. It is hoped that the same will hold good when textbooks prepared on the basis of the open-ended approach are used.

## Acknowledgement

I would like to record my thanks to Prof. V.R. Rao and to Prof. A.N. Maheshwari for the many useful suggestions they have made in developing this approach.

## References

1. Rais Ahmed and Gangoli, S.G., "Open-ended Experiments for School Science", Cyclostyled Document, DESM, NCERT (1976).
2. Gangoli, S.G., "Open-ended Experiments in Physics", *Journal of Indian Education*, **2**, p. 21 (1976).
3. Gangoli, S.G., and Gurumurthy, C., "A Comparative Study of the Effectiveness of Open-ended Approach of doing Physics Experiments Versus Traditional Approach at Higher Secondary Stage", Report of the ERIC Project, Regional College of Education, Mysore, NCERT (1985).

# Ecological Problems of Sunderbans Mangrove

P SANYAL
**Asstt. Chief Conservator of Forests**
**West Bengal, Calcutta**

*The time for high tide is half an hour more than low tide everyday. That is why there will be more deposition within the estuary, if fresh water flow is reduced from upstream. The Indian Sunderbans is thus prograding and frequent 'geomorphic highs' so created, are resulting in saline blank patches within the mangrove forest areas.*

## Introduction

Once covered with luxuriant greens of one of the highest productive mangrove forests, the largest prograding delta on globe, the sunderbans lost more than half of its lustre due to a bewildering array of ecological problems. Indian Sunderbans covered an area of 9630 km$^2$ lying south of 'Dampier-Hodges Line'. Presently, about 5350 km$^2$ area have been cleared of forests. The reclaimed land in this vast saline tract is difficult to be used fruitfully and more often it is being either far underutilized or degraded than being optimally used. The remnant forest areas of inter-tidal zone suffered continued ecological stress resulting in loss of productivity at places The resultant effect of the degradation of this largest mangrove chunk of India (61% of Indian Mangroves) caused a national concern which gradually motivated the authorities to take steps maintaining a 'conservation approach' in order to prevent the productive mangrove ecosystem from being degraded to wastelands.

## Background

The Bengal basin is suffering a gradual easterly tilt due to a neotectonic movement. The course of river Ganga subsequently changed from Tamluk (Tamralipta) area of Midnapur district on west to river Padma (present Bangladesh) on east This shift has given rise to a fall in productivity of this interface ecosystem fed by nutrients of both upstream fresh water flow as well as marine coastal sources. The excavations of Metro Rail reveal ample proof of fresh water influence within erstwhile Sunderbans Mangrove system. Large erect stems of 'Sundari' trees (*Heritiera fomes*), presence of 'Gharial' (*Gavialis gangeticus*), fresh water 'Chitra' Turtle (*Chitra indica*) in the excavations confirms the loss of productivity suffered by present Sunderbans due to such natural reasons.

The short edition of Great Indian Rhino, the Javan Rhino (*Rhinoceros sondaicus*), Swamp Deer (*Cervus duvauceli*), Water Buffalo (*Bubalus bubalis*), became extinct during last hundred years from the present Sunderbans. The reason cannot be illegal poaching, because in the same habitat more adaptable, Axis Deer, Wild Boar, Tiger, Fishing Cat who could combat the rigours of changed ecological conditions, survived.

During later part of seventeenth century human settlements started in the present Sunderbans. Reclamation of mangrove tigerland culminated during late thirties of 19th century when Sir Daniel Hamilton started first cooperative movement in India. But agriculture yielded only single crop due to lack of winter irrigation. The creek waters have average salinity of 20 D.S. $m^{-1}$ and fresh water table is below 1,000 ft deep, which renders conditions unsuitable for shallow tubewells or canal irrigation possibilities. The intertidal productive lands thus became converted to wastelands. People have to depend for half the year to eke out their living, on fishing, honey collection and wood cutting even venturing the man-eating tiger inside the mangrove forests. With the growth of population pressure and loss of productivity the existing mangrove forests were subjected to great stress and started showing signs of degradation. Biotic degraded stages of *Phoenix* grove became a prominent feature in more populated western portion of the Sunderbans.

The time for high tide is half an hour more than low tide everyday. That is why there will be more deposition within the estuary, if fresh water flow is reduced from upstream. The Indian Sunderbans is thus prograding and frequent 'geomorphic highs' so created, are resulting in saline blank patches within the mangrove forest areas.

In the Sunderbans delta, the racing tidal waters from Bay of Bengal are daily ravaging the estuary undeterred by any counteracting upstream flow. This gives rise to accelerated geomorphological changes rendering the islands more unstable. As a result there is a preponderance of 'Pioneer' and 'Seral' species like *Avicennia*, *Ceriops* but the climax species like 'Sundari', although regenerates profusely, does not get time to attain higher girths on stable lands.

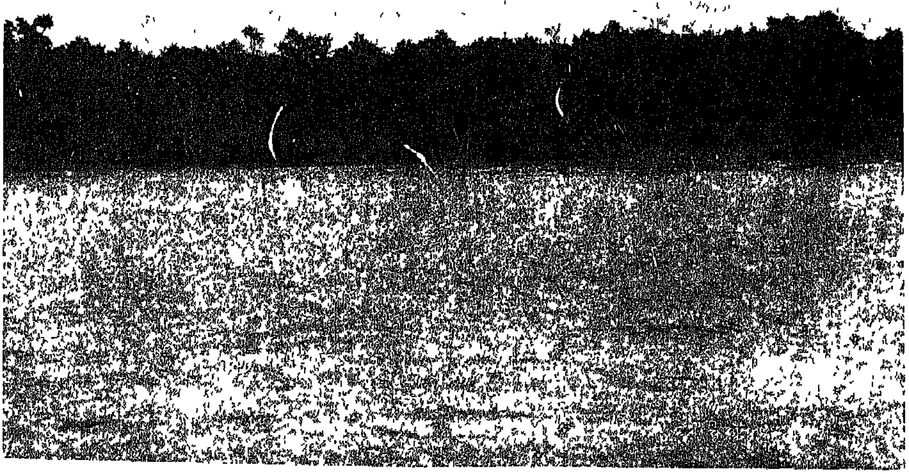


Fig. 1

Fig. 2

Except 'geomorphic highs' other lands suffer a cliff erosion followed by vertical collapse almost at 15 years intervals, whereas 'Sundari' trees take more than 20 years to attain exploitable girths.

The estuaries are enriched mainly by the primary contribution of mangrove litters. Many coastal animals including Pennaed prawns search for mangrove nursery during the postlarval stages They reach adult stage within four months in the Geberralic acid enriched creek waters and migrate very far along coastal areas to start the food chain of predators of higher ecological niche in marine aquatic system. Thus the coastal fishery is largely dependent on the estuarine input of Sunderbans. Even the nutrients are also exported from estuarine mangrove system to coastal system. In Florida it has been estimated to be 41% of total nutrient. Thus degradation of Sunderbans mangrove has a national repercussion, let alone hampering innumerable local benefits accrued thereto.

While collection of postlarval tiger prawns by the poverty stricken inhabitants of Sunderbans boosted their economy, the seeds of other lesser mullet fishes or shell fishes started getting destroyed on a large scale and created concern for *Liza persea* farmers. It is necessary to return the balance waters laden with other fish seeds back to creek water. A similar ecological problem arose when large scale hunting of estuarine crocodile (*Crocodilus porosus*) threatened the species to the brink of extinction. Problem was similar to Nile fishermen. Croc's preferred prey being predator cat fishes, who are voracious eaters of lunch dish fishes, the fishermen became distressed with depletion of crocodile population.

Last but not the least is the age-old problem of man-animal confrontation of this only mangrove tigerland on globe Down-trodden permit holders collect honey from tigerland, fish from creeks larking with crocodile and sharks, which many times cost their lives Even then man and animal have to coexist in the biosphere.

## Suggested Solutions to the Ecological Problems

In December '73 the first fruitful step was taken to conserve the extensive mangrove forests of Sunderbans by launching Project Tiger over 2585 km$^2$ area with a total conservation approach. The tiger being the top predator in the food chain was the target species so that the whole aqua-terrestrial ecosystem could be preserved in order to keep the target species in optimum numbers A contented buffer human population was tried to be created along the periphery by arranging to cater to their needs for fuelwood and smallwood, by creating employments through ecodevelopment, by minimizing menace of man-animal confrontation. As a result of the Project Tiger the endangered species were saved. The population of estuarine crocodile was increased by developing a Crocodile Breeding Farm. So far 197 crocodile hatchlings have been released in the creeks of Sunderbans in order to maintain an optimum catch of more palatable scaly fishes Several measures have been taken to minimize the man-animal confrontation, amongst which mention may be made about using of electrified human dummies to shock the man-eaters and mend their aberrated behaviour. Use of human musk at the rear side of fishermen and honey collectors also could hoodwink the stalking man-eating tigers from behind. As a result the total number of human kills within Sunderbans Tiger Reserve which used to be 48 per year till 1980s came down vying around 20 in recent times.

The conservation of mangrove species in the core area over an area of 1330 km$^2$, where no exploitation is permitted, also paid its dividends by contributing mangrove litters to the system. Honey production increased due to resultant increase of nectar bearing mangrove flowering plants. On an average every year 500 quintals of honey and 3000 kg of beeswax is extracted from the Sunderbans

The reclaimed wastelands of Sunderbans within the reach of daily tides were proposed to be afforested by mangrove plants. About 300 km$^2$ area would thus be available for restoration. In 1989 the whole Sunderbans area (over 9630 km$^2$) south of Dampier-Hodges Line was declared as a 'Biosphere Reserve'. The concept envisaged special treatment of the area dividing it in different treatment zonations viz., the 'Core Zone' coinciding with the existing core area of Sunderbans Tiger Reserve, the 'Manipulation Zone Forestry' coinciding with the forest area lying outside core area of S T R., 'Manipulation Zone Agriculture', which would cover the non-forest areas of Sunderbans including the aquaculture area and the 'Restoration Zone', which includes the barren mudflats and saline blanks of total Sunderbans. The main idea of Restoration Zone is to create mangrove plantations on the saline wastelands which would not only contribute litters to the ecosystem and increase its primary productivity but will also cater to the need of fuelwood and smallwood of local people. So far about 800 hectares of plantation have been raised and the productivity studies (above ground) were made The principal species, i.e , *Avicennia marina* yielded an annual dry weight of 24 5 M.T. per hectare which compares very well with the accredited productivity of Thailand mangroves having a figure of 27 M.T. per hectare (over ground)

The embankments of reclaimed land provide good space for planting fresh water species like 'Mysore gum', 'Subabul', 'Sonajhuri' (*Acacia auriculiformis*). The honey from Mysore gum has been found extremely tasty and can produce nectar throughout the year. The biosphere concept also takes into account improvement of paddy-cum-fishery as well as high yielding saline paddy production. It is earnestly hoped that a total ecodevelopment approach consisting of forestry, agriculture, fishery, apiculture, mariculture, oyster and crab culture, irrigation, drinking water supply, may not take a very long way to solve this age-old ecological problem of the Sunderbans biosphere.

# Elementary Facts about Elementary Particles

LALIT KISHORE
**Principal, Navodaya Vidyalaya**
**Khunga Kothi, Jind 126 102**

*Many elementary particles exist in the three electric charge values (positive, negative and neutral) and have their antiparticles too. Of all the known elementary particles only photon, electron, neutron and proton are the stable particles while all other particles decay with time*

Every high school student is familiar with the three common elementary particles, viz., neutron, proton and electron. Besides these particles there are hoards of (above 200) other elementary particles which are the ultimate building blocks of all matter. The classification of elementary particles (akin to the periodic classification of elements) is being persued by the theoretical physicists but the final pattern of grouping is still uncertain.

Basically, most of elementary particles have been discovered as a result of the nuclear reactions produced by the particle accelerators. In other words, the study of elementary particles is a part of high energy physics.

## Particle Exchange Theory

In order to know about elementary particles and their classification, it becomes essential to know about the four basic interactions, namely

1. Nuclear Interaction
2. Electromagnetic Interaction
3. Weak Interaction
4. Gravitational Interaction

These interactions take place due to the interchange of particles in the field of the four forces. The interaction between two nucleons (protons and neutrons) takes place due to the exchange of pions ($\pi$ mesons). Pions are unstable particles and have mass between that of an electron and a nucleon. The nuclear interaction is the strongest of all the forces and it is a short-range interaction.

The electromagnetic interaction takes place between charged particles. This interaction is weaker than the nuclear interaction and occurs due to the exchange of photons. Moreover, electromagnetic interaction is a long-range interaction and is as weak as one-hundredth of the nuclear interaction.

The interaction weaker than the electromagnetic interaction is called weak interaction This interaction takes place due to the exchange of boson or W-particle. Boson has not been detected yet but is supposed to be about three times heavier than a nucleon. The relative strength of weak interaction is $10^{-13}$ of the nuclear interaction.

The weakest interaction is the interaction between two masses or the gravitational interaction. This interaction exists between all particles and has an infinite range. The gravitational interaction occurs due to the exchange of the particle called graviton. Graviton is predicted to have zero rest mass and has not been detected experimentally yet The relative strength of the gravitational interaction is $10^{-14}$ of the nuclear interaction.

## Particle Families

Elementary particles are grouped into various families, viz., photon, lepton, meson and baryon families. The lepton family consists of electron, neutrino and muon. The meson family includes pions, kaons and eta particle, while the baryon family consists of proton, neutron, omega particle, xi particle, sigma particle and lambda particle. The last four particles in the baryon family are also called hyperons.

## More Facts

Many elementary particles exist in the three electric charge values (positive, negative and neutral) and have their antiparticles too. Of all the known elementary particles only photon, electron, neutron and proton are the stable particles while all other particles decay with time.

Furthermore, for all the interactions between elementary particles, physical quantities like energy, linear momentum, angular momentum and charge remain conserved before and after the interaction. With the discoveries of more and more elementary particles, one day man will be able to solve many riddles of the nature which had been baffling him for long.

# Some Observations on the Anatomy of *Marsilea Minuta* Linn. Occurring in Jamshedpur

S.N. BASU
**TGT (Biology)**
**Kendriya Vidyalaya No. 2**
**AFS, Kalaikunda, West Bengal**

---

*Although School Science is not the most suitable journal to publish original scientific findings, this study has been chosen as a good example of how a teacher can undertake a simple enquiry either to satisfy curiosity or as a part of pupils' investigatory project*

---

## Introduction

The plant was collected from a drain having loamy soil with pH value of 7.5 to 9.5. It is not uncommon to observe plants with different types of leaves on the same rhizome that may be partly submerged and partly growing in the muddy margins of the aquatic habitat.

Jameshedpur is a city of Singhbhum district under the Chotanagpur division of Bihar. It is quite rich in minerals and is known as "Steel City" of India. It lies between longitude of 85° 0′ : 86° 20′; latitude of 22° 0′ : 23° 0′ and the altitude is 159 metres. Climate of Jamshedpur is tropical-monsoonic, with an average rainfall of over 90 cm.

Survey was conducted thrice, during different seasons of the year and this plant was found growing during August to March.

The present study deals with the anatomy of different parts of the plant. Histological details are based on slides prepared by free hand sections using double stains while the peels of the leaves by single stain.

## Materials and Methods

The water fern *Marsilea* Linn. commonly known as 'pepperwort' or 'water clover' was collected with its basal portion intact.

The collected specimens were washed thoroughly to remove mud adhering to the roots. The cleaned specimens were preserved in F.A.A for anatomical observations. A few specimens were placed in the field press and ultimately given shape of herbarium for identification.

The herbarium was compared for its characters by the herbarium available at the Central National Herbarium, Calcutta.

The preserved specimens in F.A.A. were taken out for microslide preparations. Different parts of the specimens were separated and then free hand sections were cut. Peels of leaf surfaces were also taken out. Safranin and fast green combination gave satisfactory results in case of the sections. Only safranin was used for the peels. After the usual dehydration process, the sections were mounted in Canada-balsam for examination.

After microslide preparation, some photomicrographs were taken by Olympus P.M. 6 camera.

## Observations and Discussions

*Marsilea minuta* Linn. are small herbs with a slender creeping rhizome terminating in a 3-sided apical cell giving rise to 2 dorsal rows of leaves and a ventral row of roots (adventitious roots are also sometimes developed) Mature leaves quadrifoliate; in very young plant there is a cotyledonary leaf followed by simple primordial leaves and sometimes floating leaves Sporocarps are bean shaped, bilaterally symmetrical, many-celled, finally bivalved pedicelled.

**Stem:** The fundamental tissue in the stem seems to be paranchymatous with large amount of air cavities in the middle cortex conforming characteristic of an aquatic plant.

There is no serious departure from the other species in the anatomy of the rhizome. It possesses a single layered epidermis consisting of smaller cells. On the surface of the young rhizome, filiform hair are observed. The cortex is differentiated into outer, middle and inner cortex. The outer cortex of compactly arranged cells (with parenchyma cells with some tannin or latex), serve to maintain the cylindrical form of the stem The middle cortex is represented by large intercellular chambers (air cavities or arenchyma) which are separated by radial parenchyma of one cell thick, the 'trabaculae'. These are more in plants obtained from aquatic condition. The internal cortex contains a thick layer of brown sclerenchyma, some cells of which contain tannin or latex.

The rhizome possesses an amphipholic siphonostele forming a ring (Fig. 1) The xylem consist of spiral tracheids. The phloems consist of sieve tubes and parenchyma. Both the inner and outer phloem are covered by a single layered pericycle The pericycle in turn is flanked by the endodermis. The stele is limited externally and internally by endodermis. The pitch in the centre is parenchymatous in the plant obtained from aquatic condition and is sclerotic in the plant obtained from sub-aquatic or muddy condition. The branching of rhizome is in a dichotomous manner Development of the leaf on the node and origin of the peduncle at the base of the petiole can be clearly seen in transverse section of the nodal region

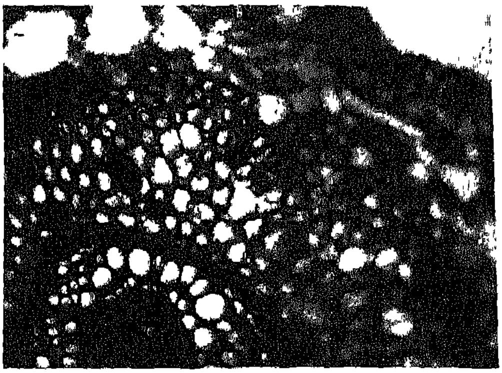


**Fig. 1.** *T.S Rhizome* × 50

**Leaf:** The lamina is made up of single layered upper and lower epidermis. The epidermal layers of the plants collected from sub-aquatic condition have anomocytic type of stomata In the leaves of the plants collected from aquatic condition with floating leaves, the stomata were restricted only to the upper epidermis. The mesophyll is differentiated into palisade and spongy parenchyma. Beneath the lower epidermis, large air chambers are present which are separated by septa However, submerged leaves show no distinction into the palisade and spongy tissue.

Vascular bundles are concentric and embedded in the mesophyll tissue. Each bundle has a central core of xylem surrounded by phloem.

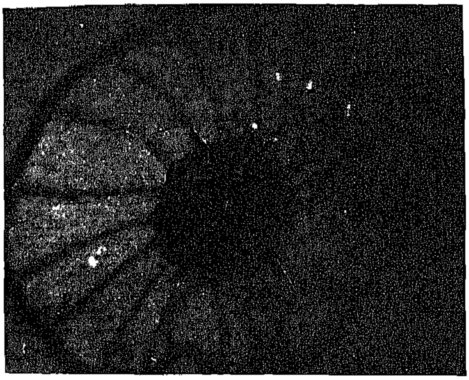


**Fig. 2.** *T.S Petiole* × 50

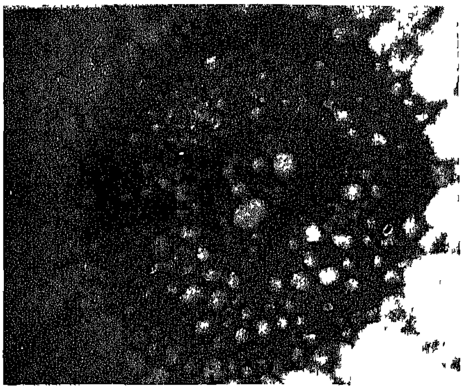


**Fig. 3.** *T S Petiole stele* × 230

Externally bundles are bounded by single layered distinct endodermis.

In the petiole (Fig. 2), a single layered epidermis is observed which is made up of rectangular cells The petiole is mainly made up of parenchyma cells having a large amount of inter cellular spaces in the external cortex, traversed radially by 'trabaculae', thus showing the characteristic of an aquatic plant. These are more in the plants obtained from aquatic condition. The inner cortex contains a sclerenchyma layer and tannin or latex cells. The inner cortex is delimited by a single layered endodermis.

The stele (Fig. 3), with the endodermis is small and elliptical. It is semicircular in a cross-section but the xylem consists of two arc-shaped bands. Each band consists of one row of scalariform tracheids, the protoxylem at both the ends of the band are small and scalariform. The phloem is situated around the xylem. Tracing the petiole upwards, two xylem arcs connect in V-shape.

**Root:** The epidermis consists of small thin-walled cells and provided with long root hair. The cortex consists of two zones. The external cortex contains large intercellular chambers, interrupted by 'trabaculae'. These are more in the plants obtained from aquatic conditions. The inner cortex is compact made of round cells containing starch or latex which often become sclerenchymatous under terrestrial condition The inner cortex is delimited by the endodermis.

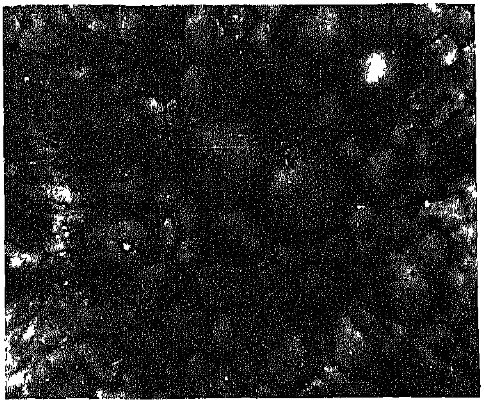


**Fig. 4.** *T S. Root stele* × 230

The stele lies within the endodermis and contains a diarch bundle with exarch xylem (Fig. 4). It is made of single layered pericycle within the endodermis and vascular tissue. The vascular tissue is composed of xylem and phloem. Two

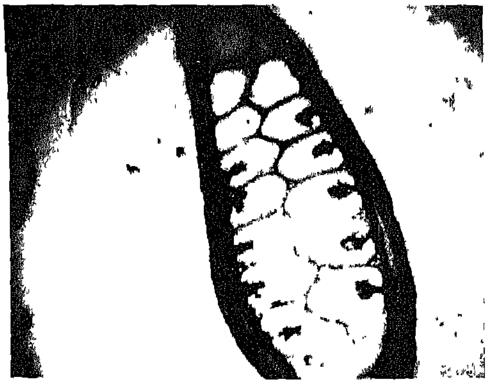


Fig. 5. *H S Sporocarp* × 120

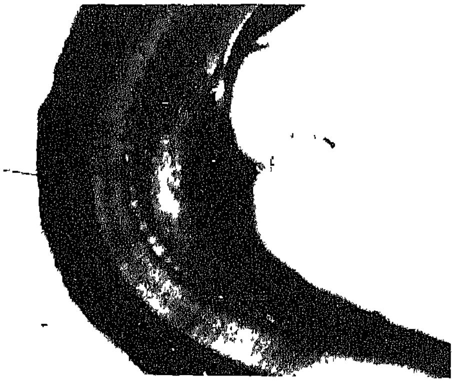


Fig. 6. *Sporocarp wall* × 230

large and two small metaxylem elements are in the middle of the elongated xylem plate. On the either side of the xylem plate, band like phloem is observed Thus, there are two xylem and phloem bundles present.

The author is unable to follow exactly the statement 'root traces are protostelic' in *Marsilea minuta* Linn. given by Puri and Garg (1953) because this term is used in describing a simple stele in which solid xylem is surrounded by phloem in a rhizome.

**Sporocarp:** The anatomy of the peduncle is similar to the upper part of the petiole with a V-shaped xylem, although its vascular supply arises in a manner of a pinna trace from the petiole. It may be a modified fertile segment of the leaf or similar to the whole leaf, more probably the former. This bundle enters the sporocarp and runs along the dorsal side and produces small branches on both sides of the shell, which then anastomose with one another and enter the receptacle of the sori, consisting of either mega- or micro-sporangia

In the horizontal section (Fig. 5), there are usually 11-13 sori observed. The distribution and development of both mega- and micro-sporangia in the sorus seems to be graded. Each sorus has micro- and mega-sporangia in advanced stages of development. The vascular bundles constituting the network of veins have been transversely cut towards the inner side of the wall of sporocarp. The thick walls of the sporocarp formed by the prism cells have been observed in the photograph (Fig. 6). When the horizontal section passes through the wall of the sporocarp only, it reveals the behaviour of the main vascular bundle quite clearly as described above.

## References

1. Allison, H.E , "Note on the Vascular Connections of the Sporocarp in *Marsilea Polycarpa*", *New Phytol.*, Vol. 10 (1911), p. 204.
2. Gupta, K.M., *Marsilea, Botanical Monograph II*, (C.S.I.R.), New Delhi (1962).

3. Gupta, K.M. and Bharadwaja, T.N , "Indian Marsileas: Their Morphology and Systemetics. 1. *M. aegyptiaca* Willd., with Remarks on the Present Systematic Position of Indian Species", *J Bombay Nat Hist. Soc.*, Vol. 53 (1956), p. 423.
4. Henderson, R.V., "The Development and Structure of the Juvenile Leaves in *Marsilea Quadrifolia*, with Notes on the Anatomy of the Stem and Adult Petiole", *Proc. Indian Acad Sci.*, Vol. 42 (1932), p. 61.
5. Ogura, Y, *Comparative Anatomy of Vegetative Organs of the Pteridophytes*, 1971.
6. Puri, V. and Garg, M.L., "A Contribution to the Anatomy of the Sporocarp of *Marsilea minuta* Linn. with a Discussion on the Nature of Sporocarp in the Marsileaceae", *Phytomorphology*, Vol. 3 (1953), p. 190.
7. White, R.A., "Vessels in the Roots of Marsilea", *Science*, Vol. 133 (3458) (1961), 1073.

# Mobile Satcoms for the Future

JOHN R. NORBURY
**Rutherford Appleton Laboratory**
**near Oxford**

*We have come to regard the geostationary satellite as the norm for communication between fixed stations and mobile stations such as ships and aircraft Recent studies show the advantages of a highly elliptical orbit when planning satellite communications with land-based mobile stations, offering much better coverage at higher latitudes.*

Nearly all recent proposals for satellite communications systems to provide a service to mobile stations have common features They include the use of geostationary satellites, operating at radio frequencies around 900 MHz or 1 5 GHz, either low-gain omnidirectional antennas or higher-gain steerable directional antennas for the mobile terminals, and communication on narrow frequency bands which permits only a single channel to be carried on each allocated frequency (known as single channel per carrier, or SCPC, access techniques, which means restriction of data transmission rates to the low figure of some 16 kilobits $s^{-1}$).

Communication *via* geostationary satellites gives global coverage from a three-satellite constellation, which is ideal for most maritime and aeronautical applications, but it suffers from somewhat severe propagation problems when the line-of-sight path from the ground station to the satellite is at a moderate angle of elevation. This is especially so with land mobile satellite services (LMSS), where the low angle may lead to multipath propagation effects, attenuation by trees and blockage of the signal by buildings or uneven terrain. These factors place considerable constraints on the type of system that can be planned For land mobile stations, there has to be a tolerance of fading of the signal power by a ratio of about 30:1, which in the communications engineer's parlance is a 15 dB (decibel) fading margin, to ensure a 90 per cent probability of acceptable speech communication over 90 per cent of the terrain covered in suburban and rural areas of North America.

Europe, with its more northerly situation and its mountainous terrain both in northern and southern regions, may need an even greater margin if there is to be a good enough service.

Cost considerations of land mobile stations call for simple, low-cost antennas; that in turn means the satellite should have a very large effective transmitter power to provide a service of commercial standard. This criterion could be met by using high power transmitters and large satellite antennas, but only at a considerable penalty to the overall system cost.

## The Molniya Orbit

An alternative to the geostationary orbit is the 12-hour Molniya orbit, used extensively by the Soviet Union and illustrated in the first diagram. It is a highly elliptical orbit which provides a satellite position giving angles near to that at zenith, when viewed from Earth at moderate latitudes, for eight hours of its orbit time On

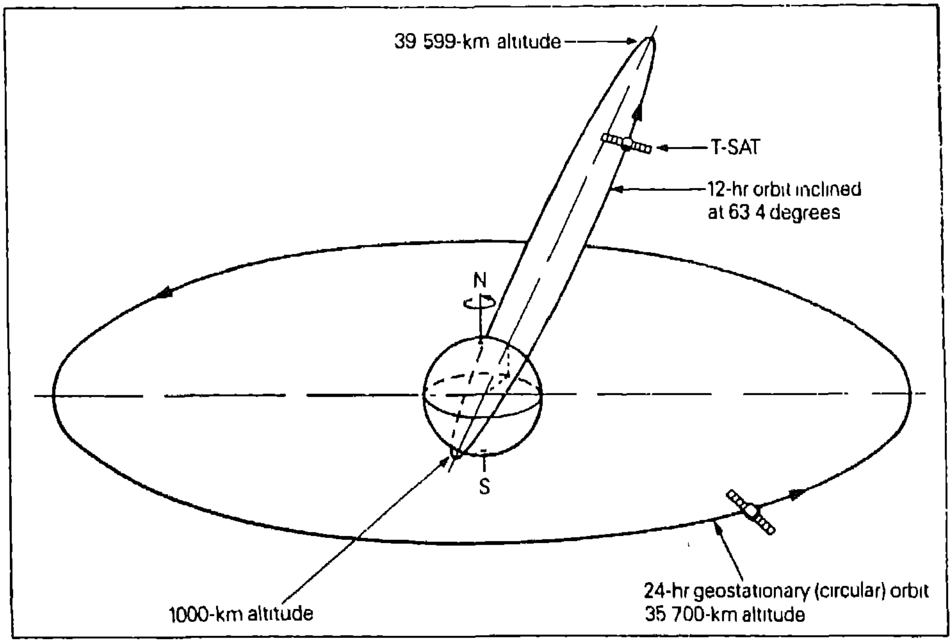

39 599-km altitude
T-SAT
12-hr orbit inclined at 63 4 degrees
N
S
1000-km altitude
24-hr geostationary (circular) orbit 35 700-km altitude

**Fig. 1.** *The Molniya satellite orbit compared with the geostationary (circular) orbit*

alternate orbits it provides a further eight hours for a region at the same latitude but 180 degrees different in longitude. For 24-hour coverage over one region means using three satellites in three orbital planes separated by 120 degrees Obviously, any such constellation of satellites also gives coverage for a region 180 degrees different in longitude from the originally planned region. Elevation angles for Europe and polar regions would be high, as is shown by the 'beam footprints' in the second diagram.

The left-hand part of the diagram shows the view of Earth from a satellite in a Molniya orbit with its apogee at 3.5°W. To the right is the view from the equivalent geostationary position. Coverage of the polar region is seen to be excellent using the Molniya orbit, in contrast to that provided by geostationary orbit where the elevation angle to the satellite is zero at about 81 degrees North or South. This means that to provide complete polar coverage, even for fixed point-to-point communications services, satellites in non-geostationary orbits are needed.

Several satellite configurations are possible for LMSS, selected to reduce the overall power needed in the satellite and, thereby, the overall system cost. Constellations of satellites in low orbits have been proposed in the USA, and Canadian scientists have studied 12 and 24-hour elliptical orbits in detail. British studies, published by the U.K. Institution of Electrical Engineers, have investigated the application of Molniya orbits to

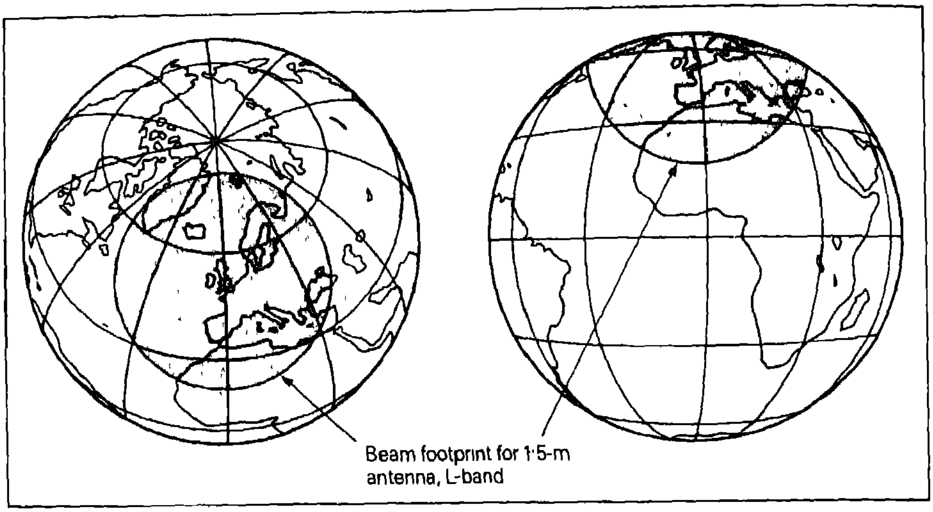


Fig. 2. *Comparison of coverage by (left) a Molniya orbit and (right) a geostationary orbit*

provide U.K. coverage for LMSS. Such systems have several advantages for Europe. The elevation angles are greater than 60 degrees and there is the possibility of using high gain non-steerable antennas for the mobile stations. Furthermore, the reduction of multipath propagation with such an orbit adds to these factors to remove many of the constraints imposed by a geostationary orbit system. It means the fading margin that has to be tolerated is reduced to a few decibels, and the gain of the mobile station antenna could be as high as 15 dB, so the link can be engineered taking into account a starting advantage of some 100 times more antenna-to-antenna power being available, from base station to mobile, than in the geostationary system. And, although it is necessary to provide a three-satellite constellation for coverage over 24 hours the launch energy needed to place a satellite into a Molniya orbit is roughly half that for a geostationary equivalent.

The capital cost of a satellite system tends tc be related directly to the amount of radio-frequency power needed for the link. So any configuration that reduces the power needed per voice channel, as in the case of the elliptical orbit satellite, makes the system a great deal more commercially attractive. The provider of a satellite mobile service would have the choice of an initial system of satellites working at relatively low radio frequency power per voice channel, or have many more revenue-earning channels for the same capital cost as in a geostationary system.

Studies conducted recently in the U.K. favour a 12-hour elliptical orbit, because it would be the lowest cost option for a demonstration satellite. But the orbit does pass through the Van Allen radiation belts, which could degrade electronics devices and solar panels. A so-called Tundra orbit, taking 24 hours, enables this high radiation environment to be avoided. When deciding on the best orbit for an operational system, it will be necessary to compare the three-satellite Molniya constellation, using a low launch energy and small satellite antenna, with the two-satellite Tundra system where launch costs are higher, antennas are bigger but the radiation environment is better.

## Transmission Frequencies

Procedures for allocating frequencies for radio systems are co-ordinated through the International Telecommunication Union (ITU). Radio transmissions do not respect national boundaries, so agreeing uses of the radio spectrum tends to be rather lengthy. A series of World Administrative Radio Conferences (WARC) are held at suitable intervals to agree international usage. However, at the last major conference, WARC 79, no part of the spectrum below 20 GHz was allocated to land mobile satellite services in the European region (Region 1), whereas a small allocation at UHF was allocated for use in the Americas (Region 2) and Asia (Region 3).

This lack of spectrum is a big stumbling block for any commercial satellite land mobile service. A special conference, WARC MOB 87, has been organised to take place during 1987 to tackle the problem. Several solutions seem possible, with frequency slots in the regions of 1.5 GHz, 2.5 GHz and 5 GHz being topics for discussion. Although the conference might be mainly devoted to considering geostationary systems, some attention will also be given to elliptical orbit systems.

## Payload Study

For several years a university consortium in the U.K., whose members are listed in the accompanying table and whose activities are co-ordinated by Rutherford Appleton Laboratory, has been studying advanced ideas for satellite communication systems under the banner of Communications Engineering Research Satellite (CERS). Two ideas that have generated considerable interest are the use of on-board processing of signals in satellite systems and the application of the Molniya orbit. This group is now in the middle of a two-year project in which an electronic model of a mobile payload with full on-board processing is being built.

The design of the proposed payload is outlined in the final diagram A simple reflector of 1.5 m diameter is planned for the antenna, the necessary steering to point to Earth in a Molniya orbit to be achieved by manoeuvring the satellite. Depending on the data rate, a transmitter power of between 10 W and 20 W will be needed.

**Members of a consortium of university-based and other laboratories taking part in the mobile payload study**

| *Member of consortium* | *Area of study* |
|---|---|
| Bradford University | Mobile system/ system design |
| King's College, London University | Microwave system |
| Surrey University | On-board processor/ system design |
| Loughborough University | Modulation/ demodulation |
| Manchester University | Coding/decoding |
| Portsmouth Polytechnic | Doppler correction |
| Queen Mary College, London University | Antenna |
| Rutherford Appleton Laboratory | Co-ordination/ system concepts |

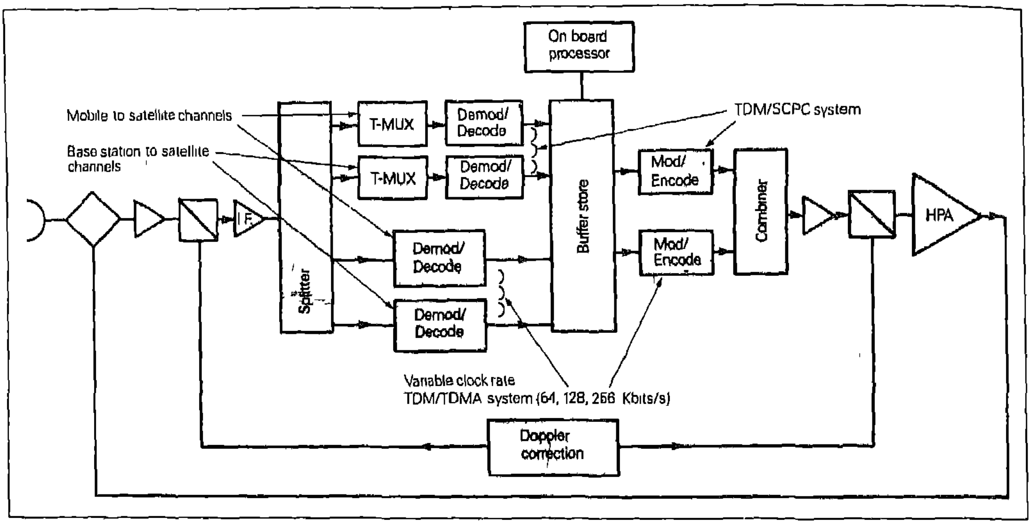


**Fig. 3.** *Proposed scheme for the satellite-borne payload to be used for communication with mobile and base stations*

Full demodulation and decoding of the received signals would be included, using a variety of schemes There are several modulation schemes to be considered, including one in which the carrier is phase-shifted by the data keying process. Decoding would be possible for a variety of coding schemes. An on-board micro-processor would control an electronic buffer store to allow re-formatting of data and re-transmission using modulation and coding schemes that would be independent of the up-link channel.

Access schemes for communication with the satellite are, first, time division multiplexing (TDM) on the down-link to mobile stations with time division multiple access (TDMA) on the return path from mobile station to satellite; second, TDM on the down-link to mobiles with SCPC on the up-link. The payload, by using dual channels for each system of access, allows full duplex (simultaneous two-way) operation. Both up and down channels would operate in the L-band (1.5 to 1.6 GHz), with data rates of 64, 128, 256 or 512 kilobits $s^{-1}$.

The motion of the satellite in the Molniya orbit causes a doppler shift in the transmitted and received signals. It is intended to compensate for this on board the satellite by controlling the frequencies of its local oscillators, using either an on-board control system or ground control.

Different types of traffic such as short, coded messages or voice or facsimile could be accommodated within the same time frame merely by varying the length of the time slot allocated to each individual service by the multiplexing system. The full capacity of the system, using 4 8 kilobits $s^{-1}$ voice coding would be about 50 voice channels.

For the mobile station, an antenna with an angle of ± 15 degrees could be used, mounted on the vehicle roof with its axis pointing vertically. Dimensions of less than one metre square are possible for this. The power of the mobile transmitter would need to be about 20 W The only obstruction that may be expected to impair reception are overhead bridges or vegetation, or multipath scattering that might occur from very tall buildings. System coverage, in time and space, would be better than 99 per cent.

If the justification for satellite systems to provide communication with mobile stations is that they would fill in *all* the gaps not covered by a terrestrial-based cellular system, it might be questionable whether a geostationary service will be attractive enough commercially at such a level of coverage. An elliptical orbit system, although resorting to the complexity of operating a constellation of satellites, offers almost complete coverage even in urban areas and at greatly reduced signal strength requirement. Further spin off might be found if these ideas were implemented in a European mobile system The technology developed could equally well be applied to both mobile and fixed service systems for the equatorial regions of the Earth operating with a geostationary satellite. If this mobile satellite solution is commercially viable for Europe, then the cost of the transmitter-receiver, produced in quantity, would have to be comparable with those used in terrestrial mobile systems, namely of the order of £1000. The potential for such technology, in regions where satellite systems offer the most practical way of providing mass communication, seems considerable.

Courtesy: *Spectrum*

# A Technical Effort of Biology Teaching: Hospital as an Aid

V.K. DIXIT
**PGT Biology**
**Kendriya Vidyalaya**
**Tenga Valley, Arunachal Pradesh**

*It is true that many tests, experiments are done in the school labs But India is a poor country So, every school lab cannot be equipped with each and every facility required for demonstration. So, a nearby hospital can be used as a good substitute for a laboratory*

The National Policy on Education (NPE), 1986 has emphasised the importance of science education at all levels. In the new curriculum of secondary education, science is treated as one area of human endeavour up to Class X. After a broad exposure to an integrated treatment of certain basic concepts in science, students entering Classes XI and XII would be introduced to individual disciplines, such as Physics, Chemistry, Biology and Mathematics.

The vast majority of Indian students are first generation learners and those who would pursue science as a career constitute a very small minority.

Moreover, today, Biology as a discipline of science has barged into every walk of life. It is an indispensable area of human knowledge for the physical, social and mental well-being and the scientific and technological growth. Students opting for Biology as a subject of study at the senior secondary stage need to be prepared adequately for the academic and professional courses at the tertiary level of education, and those who drop out after the senior secondary stage and enter the world of work need to be more equipped to meet the challenges of life

The task of (1) achieving the above mentioned dual objectives, (2) inculcating a spirit of enquiry, creativity, objectivity, aesthetic sensibility and an abiding environmental consciousness in a child, and (3) developing a broad-based biological knowledge, stimulating a deep interest in the natural world, teaching problem solving and decision making skills can be eased with a little effort from our end.

The act of discovery is always new and is one's own. Even if the object of discovery has been found by someone before, the joy is fresh every time when one rediscovers something for the self. For, in doing so we recreate the mental images through which we understand the world. The understanding that it brings is at once a source of spontaneous joy as well as of an urge to use the laws of nature in noble ways to refashion our world for the benefit of mankind.

Of all the methods commonly adopted by teachers like lecture method, demonstration method, laboratory method, discovery method, project method, problem-solving method etc., the demonstration method has a vital role to play to eradicate non-effectiveness of teaching, non-conceptualization in learner's mind. It will be apt to re-emphasise demonstration method. In order of significance, demonstration method has the following advantages.

1. It makes learning experience more concrete than it is possible in conventional method.
2. It helps the student to observe different skills and master them accordingly
3. Demonstration appeals to both the senses, the eyes and the ears of the student.
4. Application of principle(s) is seen immediately being utilised.
5 It improves the communication process.
6. Demonstration method is useful where students cannot be provided with costly equipment as well as for risks involved in handling it
7 It is suitable for group teaching and understanding of concept in comparatively less time than it is possible in case of laboratory or problem-solving method.

It is worth mentioning that the NCERT textbook in Biology deals with the following simple and abstract concepts·

- Dental pattern, salivation, food digestion, absorption, vitaminosis, malnutrition and stool test;
- Lungs, bronchioles, artificial respiration providing $O_2$, gas exchange, and lung diseases,
- Blood and its content testing, blood grouping, anaemia;
- Heart and its functioning, heart abnormalities, blood pressure and ECG (electrocardiogram);
- Kidney, its functioning, urine test;
- Skeleton, muscles and their role in movement and locomotion of human beings, fracture and sprain, role of Plaster of Paris bandage, physiotherapy;
- Central nervous system, eyes, ears, tongue, nose, skin and their functioning, apparatuses to examine them, curing diseases etc.;
- Hormone regulation;
- Reproductive organs, tissues, their physiology, tubectomy, vasectomy, and birth control methods,
- Several embryonic stages, their growth and development,
- Genetical experiments like observation of chromosome, genes;
- Bacterial culture, microbial studies;
- Application of biological knowledge in the form of applied Biology such as biotechnology, technology used for medical application, and so on.

These concepts can be made easily understandable if they are carried out with the cooperation of an hospital which is easily accessible to higher secondary schools Various equipments, instruments, tests and hospital mechanism can be observed by them

It is true that many tests, experiments are done in the school labs. But India is a poor country So, every school lab cannot be equipped with each and every facility required for demonstration. So, a nearby hospital can be used as a good substitute for a laboratory

The purpose of performing and presenting this experiment is

1 to make learning optimum,
2. to justify that the role of demonstration as a teaching aid cannot be avoided,
3 to justify that if a planned trip of students of XII standard of Biology stream is taken round the hospital in the beginning of session and after the curricular chapters are taught to them, there will be more learning outcome,
4. moreover, concretization of thoughts will be more than in traditional teaching in a classroom,
5. teaching-learning process will fastened,
6 it will bring learning into day-to-day practice.

Keeping in view the above facts, a trip of fifteen students of XII Science (Biology) of K.V. Tenga Valley was taken to Military Hospital of Dahung near Tenga Valley Previous knowledge and post-visit knowledge of students were tested by the Biology teacher by making a questionnaire table on tests/equipments carried out in practice in hospitals.

It was observed that the students belonged to age group 16-17 years and occupationally their parents belonged to defence services except two students whose parents belonged to medical profession

When asked about any idea of test/equipment students' response was negative for all items except methods of birth control which shows 72.6% students had its theoretical knowledge from various resources.

The list of test items/equipments was sent in advance to the hospital The students were taken round the hospital in the beginning of the session. They were taken to the following departments·

Firstly, all the students were accommodated by the radiographer in radiography chamber, where X-ray machine working mechanism was discussed. Students developed knowledge that barium water is fed to a patient to observe functioning of his stomach, lung, heart and other body organs. Even inside of the whole body can be recorded in photography plate.

Secondly, ECG machine and its operation on a patient was observed.

Thirdly, procedure of blood bank, blood grouping, blood content testing, procedure of bacterial cultures, identification of microbes like plasmodium, filarial worm was observed.

Fourthly, urine tests, stool tests were observed

Fifthly, students observed a minor operation carried out on a patient.

Finally, students were taken to the gynaecologist who described various methods used for birth control and showed some of the items like contraceptive pills, condoms, loops, copper T, and explained about MTP (Medical Termination of Pregnancy), vasectomy, tubectomy.

Post-visit test taken by the teacher showed very much positive results.

Regarding follow-up of the subject on the basis of knowledge, understanding and application, it showed positive results too, broadening the scope and horizon of understanding.

It was less time consuming and more effective than school laboratory method and classroom teaching.

Remedial help could be provided to the weaker and average students.

It quickened teaching-learning process in comparison to pre-hospital visit classes.

It is advisable to follow this practice to enhance the teaching-learning process Although it may have some limitations, like pre-planning in the beginning of the session, school administration and hospital administration problems, the positive outcomes favour this approach.

## References

1. *Science A Textbook for Class X*, NCERT, 1989.
2 *Biology: A Textbook for Class XI*, NCERT, 1989.
3. *Biology: A Textbook for Class XII*, NCERT, 1989.
4. Mohanty, S.B , *Method of Teaching Science*, Books and Books, Binod Behari, Cuttack, p. 64.

# Operation of Union and Intersection on Sets

MARLOW EDIGER
**Division of Education**
**Northeast Missouri State University**
**Kirksville 63501, USA**

Pupils in the elementary school should have learning activities in mathematics which are interesting, meaningful, and purposeful. "Learn by discovery" is a key concept in having pupils develop conclusions and generalisations in elementary school mathematics.

Pupils in the first grade can discover meanings pertaining to the operations of union and intersection on sets, which are disjoint as well as not disjoint, providing that the learning activities provided for them are interesting, meaningful, and purposeful. The operation of union of disjoint sets will be discussed first.

## Union on Sets

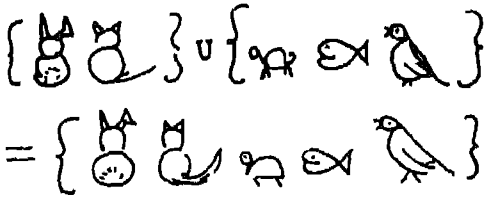
1. Use actual objects or pupils in the classroom. Pupils who have developed understanding pertaining to rational counting can also develop important understandings pertaining to the union of sets Two boys can stand in front of the classroom representing one set with three other boys in the second set. The question can be asked, "How many boys do we have if the two sets are joined?" The order of the sets could be changed when these pupils representing the two sets are standing in front of the classroom. Pupils could inductively develop the understanding that the operation of union on sets is commutative (pupils would develop the generalization in their own terminology which is meaningful to them) Real objects such as books, rulers, pencils, crayons, and toys can also be used to help pupils understand meanings pertaining to the operation of union on sets as well as the commutative property of union.

2 Use pictures. Pupils enjoy looking for pictures in discarded magazines in school as well as in the home They can look for pictures of boats, cars, trucks, buses, and people. Set one could be made up of two cars such as a Chevrolet and a Ford while the second set has three members—Plymouth, Rambler, and Dodge. The question that can be answered by pupils is, "If we join the cars in both sets to make a new set, how many cars do we have in this new set?" The commutative property of union should also be emphasized by changing the order of the two sets.

3. Use the flannel board. There should be felt cut-outs of various animals, people, cars, trucks, and geometric designs for pupils to utilize in responding to questions involving the joining of two sets Using cut-outs which name a variety of animals, people etc , provide for variety in learning activities for pupils thus helping to maintain pupil interest. (The same would be true for varying the actual objects and pupils in developing sets as well as in the use of pictures). When the flannel board is used, as well as in previous times, pupils should be able to describe a set accurately. For instance, the teacher could put the following on the flannel board:

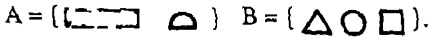
and have pupils tell about the set. The discussion would end with an accurate description of the set. Another set could be placed on the flannel board such as:

This set would also be described accurately. The question that can now be raised is, "If the two sets are joined, how many members do we have in the new set?" The new set that results can be visualized by pupils such as:



Pupils should understand that what is located within the braces makes up the members of a given set. The commutative property of union can also be visualized by pupils when changing the order of the two sets. Pupils at this stage of learning need also to understand a related understanding to the operation of union and that is the operation of addition on numbers such as $2 + 3 = 5$ in the previously discussed example. The number of members of the first set was two, and the number of members of the second set was three: $2 + 3 = 5$

4. Review previous learnings and utilize abstract symbols more frequently. In this stage of achievement pupils can deal effectively with more abstract symbols than previously. Sets on a flannel board can be labelled such as.



Pupils can work problems using numerals only, such as

$$3 + 2 = \square \quad , \quad 3 + \square = 5$$

$$2 + 3 = \square \quad , \quad \begin{array}{r}3\\ \underline{+2}\end{array} \qquad \begin{array}{r}2\\ \underline{+3}\end{array}$$

and other addition facts that pupils have developed understandings to previously when persons, objects, pictures, and the flannel board were used. The teacher needs to remember that learning activities need to be varied to develop and maintain pupil interest as well as provide for individual differences among pupils.

**Intersection on Sets**

Pupils toward the end of the first grade can also discover the operation of intersection on sets. The operation of intersection on sets should be presented shortly after pupils develop understandings pertaining to the union of sets which are not disjoint.

1 Use dramatizations. These dramatizations should be realistic and life-like. Don, Bill, and John are on a committee to feed pets in the classroom for one week. Ann, Judy, and Bill are on a different committee to take care of the plants in the classroom during the same week. Pupils could be asked, "Who are the members of the committee to take care of the pets in the classroom this week?" The names of the members of the committee to take care of the pets in the classroom this week should be written on the chalkboard, {Don, Bill, John}. "Which pupils are members of the committee to water plants this week?" These names should also be written on the chalkboard, {Ann, Judy, Bill}. Pupils could now see the two sets placed side by side such as:

{Don, Bill, John}, {Ann, Judy, Bill}.

The next question that can be raised is, "How many members make up the two sets if they are joined?" If pupils respond with "six," the teacher needs to have the members of both committees come to the front of the room in order that all pupils can understand that there are five members making up the "union" of the two sets. On the chalkboard the teacher can finish writing

$$\{\text{Don, Bill, John}\} \cup \{\text{Ann, Judy, Bill}\}$$
$$= \{\text{Don, Bill, John, Ann, Judy}\}$$

during the final phase of the dramatization. Several dramatizations need to be viewed by pupils so that they clearly understand the meaning of the operation of union on sets which are not disjoint. Pupils should also understand the commutative property of union through dramatization at this point.

The teacher should now have pupils develop inductively an understanding of the operation of intersection on sets. Pupils in the classroom can be asked "Who is on the committee to feed our pets in the classroom this week?" Pupils will respond with the following names—"Don, Bill and John." On the chalkboard the teacher can write {Don, Bill, John}. The next question asked of pupils could be the following: "Who is on the committee to take care of our plants in the classroom this week?" Pupils should respond with the correct names, "Ann, Judy and Bill." The teacher on the same line on the chalkboard writes {Ann, Judy, Bill}. The teacher can now ask, "Which member is on both committees?" After pupils have responded correctly, the teacher can finish writing:

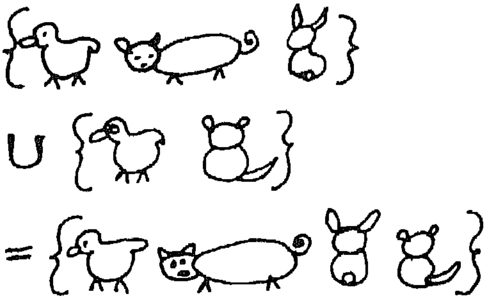
$$\{\text{Don, Bill, John}\} \cap \{\text{Ann, Judy, Bill}\}$$
$$= \{\text{Bill}\}.$$

Pupils should develop an accurate, meaningful understanding of the abstract symbol for the operation of intersection. Several dramatizations should be used in order that pupils understand the meaning of a member being common to two sets.

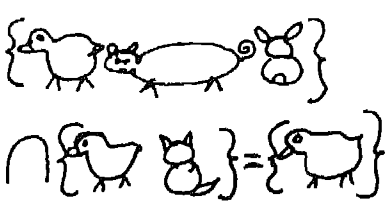
2. Use the flannel board. Cut-outs of animals, people, cars, trucks, and geometrical designs can be used. The teacher can place a felt cut-out of a duck, pig, and rabbit in one set such as

Beside it, a second set could be placed made up of a duck and a cat such as:

Pupils under teacher guidance could describe accurately each set. The teacher could now ask "How many different kinds of farm animals would there be if we joined the two sets to make a new set?" If some pupils respond with "Five", in a discussion pupils can develop the understanding that duck is a member of both sets; there are four members in the new set which can be visualized by pupils as.



Since "duck" is common to both sets:



3. Use abstract symbols. The letters of the alphabet, the days of the week, and/or the months of the year can be written on the chalkboard. For instance, pupils are asked to name the first three days of the week for one set; as pupils mention

the names, the teacher can write the set as {Sunday, Monday, Tuesday}. The teacher can then ask pupils to name the last five days of the week; the teacher or another pupil can write on the chalkboard the second set consisting of the last five days of the week {Tuesday, Wednesday, Thursday, Friday, Saturday}. The teacher then asks pupils, "If the two sets are joined, what members make up the new set consisting of the days of the week?" The teacher writes the names as they are mentioned by pupils. If pupils respond with the following as being the union of the two sets mentioned previously, "Sunday, Monday, Tuesday, Tuesday, Wednesday, Thursday, Friday, Saturday", the teacher can have pupils look at a calendar in order to name the days of the week. Most pupils can, of course, at this point recite the days of the week. Pupils can inductively develop the understanding that

$$\{\text{Sunday, Monday, Tuesday}\} \cup \{\text{Tuesday, Wednesday, Thursday, Friday, Saturday}\} = \{\text{Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday}\}.$$

At this point pupils can also be asked, "Which member is common to both sets?" The teacher, after receiving the correct response from pupils, can write on the chalkboard:

$$\{\text{Sunday, Monday, Tuesday}\} \cap \{\text{Tuesday, Wednesday, Thursday, Friday, Saturday}\} = \{\text{Tuesday}\}.$$

Pupils should notice the symbol "$\cap$", and how it differs from the symbol "$\cup$" used in joining the two sets A discussion should follow in which the symbols "$\cup$" and "$\cap$" become differentiated and understood by pupils so that meaningful learning may take place

Further learning activities for pupils in understanding what in adult terms would be the "union and intersection of sets which are not disjoint" could be the following:

Have pupils name the first two months of the year for the first set. Next, have pupils name the first three months of the year as the second set. Write the specific sets on the chalkboard at the time they are given by pupils. Disagreement among pupils as to the correct sets wanted can make for excellent discussions in the classroom; in these discussions pupils reveal correct as well as incorrect understandings. If pupils want to mention the names of months more than once in the union of the two previously mentioned sets such as incorrectly stating that

$$\{\text{January, February}\} \cup \{\text{January, February, March}\} = \{\text{January, February, January, February, March}\},$$

the teacher can ask the question "What set is made up of the first three months of the year?" After a discussion, pupils will generalize that the set consisting of the first three months of the year is {January, February, March} and not {January, February, January, February, March}.

Pupils could then be asked which member or members are common to both sets The teacher can write pupil responses on the chalkboard as they are given using the appropriate symbols for sets named and the correct symbol for intersection of the two sets.

The order of sets can also be changed so that pupils can inductively understand that in union and intersection of sets the order is not important.

## Selected References

1. Ashlock, Robert B. *Error Patterns in Computation*, Columbus, Ohio: Charles E. Merrill Publishing Company, 1982.

2. Bley, Nancy S., and Carol A. Thornton. *Teaching Mathematics to the Learning Disabled*, Rockville, Maryland. An Aspen Publication, 1981.
3. Ballew, Hunter. *Teaching Children Mathematics*, Columbus: Charles E. Merril Publishing Company, 1973.
4. Cawley, John F. *Cognitive Strategies and Mathematics for the Learning Disabled*, Rockville, Maryland· An Aspen Publication, 1985.
5. Fehr, Howard F. and Jo McKeeby Phillips. *Teaching Modern Mathematics in the Elementary School*, Second Edition, Reading, Massachusetts: Addison-Wesley, 1972
6. Higley, Joan. *Activities Deskbook for Teaching Arithmetic Skills*, West Nyack, New York: Parker Publishing Company, 1983.
7. Jenson, Rosalie *Exploring Mathematical Concepts and Skills in the Elementary School*, Columbus: Charles E. Merrill Publishing Company, 1973.
8. Kennedy, Larry G. *Guiding Children's Learning of Mathematics*, Fourth Edition, Belmont, California: Wadsworth Publishing Company, 1984. Chapter One.
9. Lesh, Richard and Marshall Landau (Editors). *Acquisition of Mathematics Concepts and Processes*, New York· Academic Press, 1983.
10. Stern, Catherine, and Margaret B. Stern. *Children Discover Arithmetic*, New York: Harper and Row, 1971.

# Puzzle on Scientists

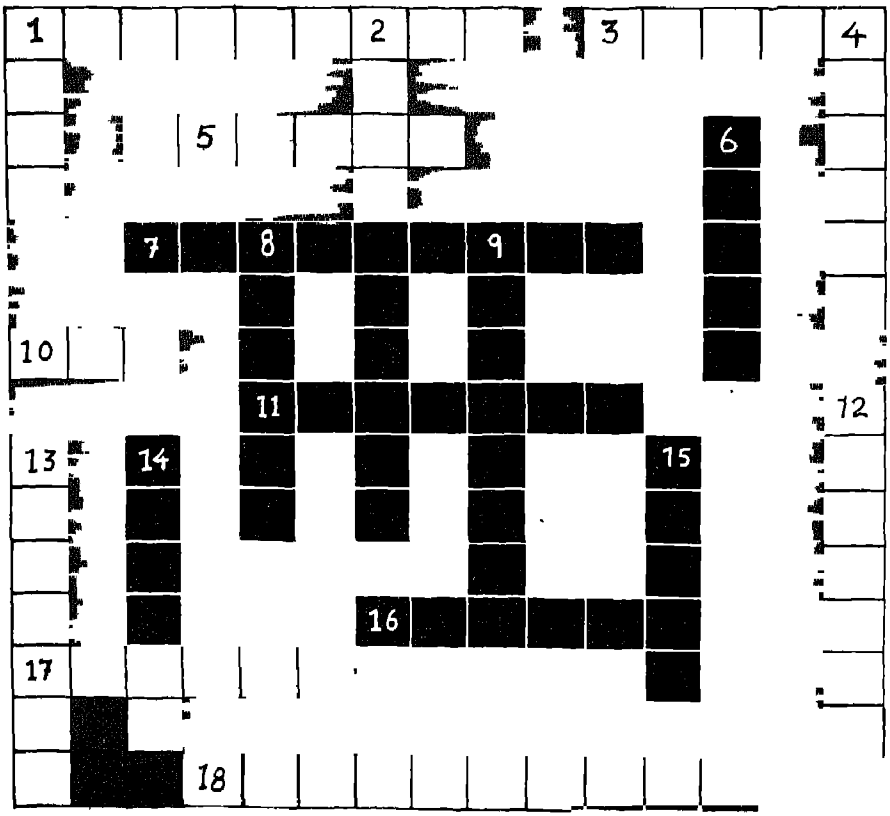
**Clues**

*Across*

1. His encounter with radio activity was accidental (9).
3 Usherer of the quantum mechanics (5).
5. The value of frequency is incomplete without him (5).
7. His classification of elements is valid even now (9).
10. Reversal of his name gives unit of conductivity (3).
11. Discoverer of electron (7).
16. Austrian monk crossed flowering plants (6).
17. Man to acknowledge his relation with ape (6).
18. Still lingering with body temperature (10).

*Down*

1. He saw solar system in an atom (4).
2. Established existence of atomic nucleus (10).
4 Planets moved even without his laws (6).
6. An Indian famous for his effect (5).
8. He combined seven colours (6).
9. He put a limit on speed of light (8).
12. Author of the book *The Starry Messenger* (7).
14. He measures current (6)
15. He replaced calorie (5).



# Science News

## 100 Galaxies Causing Distortion

Like an immense gravitational magnet, a vast celestial structure nicknamed "the great attractor" is pulling powerfully at the Milky Way and more than 100 other galaxies, causing a dramatic distortion in the normal expansion of the nearby universe. The structure has been shown in new studies to be pulling on galaxies from across more than 100 million light years of space, astronomer Mr. Alan Dressler of the Carnegie Institution, Washington, told a meeting of the U.S. Astronomical Society.

Mr. Dressler said that he and Ms. Sandra Faber of the University of California at Santa Cruz have confirmed the influence of the great attractor by measuring the movements of about 400 galaxies and comparing the motion with what is considered normal for an expanding universe.

More than 100 galaxies were found to have a "peculiar motion" that pointed towards the centre of what Mr. Dressler labelled the great attractor. The theory is that the universe is expanding at a steady rate, hence all galaxies are moving in one direction at a constant rate. Any change in rate or direction is considered "peculiar motion".

"The great attractor is a large area density in which galaxies are moving towards it from one side and towards it from the other," Mr Dressler said "The distortion in motion is very marked and very significant." Mr. Dressler said that the gravitational pull of the great attractor has added about 600 km a second to the motion velocity of the galaxies it is drawing in.

Mr. Dressler, Ms. Faber and five other astronomers, called the "seven samurai" in the astronomy community, presented preliminary evidence for the presence of the great attractor in 1987 The idea was met then with great skepticism because it went against theories that matter formed in generally smooth patterns in the universe. They had found a rather large lump Their studies then showed that only galaxies on the same side as the Milky Way were being drawn towards the attractor.

Since then, he and Ms. Faber have found many additional star clusters also moving towards the great attractor There is evidence now that galaxies are falling in from the other side. Measurements have determined that the great attractor is about 500 million light years across and that the centre of the structure is about 150 million light years away from the Milky Way, which is the home of the sun and the earth.

## Asteroid Named after Ramanujan

The first asteroid discovered by Indian astrophysicists has been named after the mathematical genius Srinivasa Ramanujan.

The asteroid was spotted by a team of scientists led by Dr. R. Rajamohan with the help of the 45 cm Schmidt telescope at Vainu Bapu Observatory (Kavalur) of the Indian Institute of Astrophysics. The orbital parameters were derived and submitted to the minor planets centre of the Smithsonian Observatory, U S.A. This centre had assigned the number 4130 to the planetoid and published the findings of the Indian team in the circular brought out on behalf of the International Astronomical Union.

Dr. Rajamohan said a communication was sent to the minor planets centre on christening the asteroid after Dr Ramanujan. A citation listing the Mathematical wizard's signal contributions was also sent along with the communication, he added.

Srinivasa Ramanujan will be the latest addition to the list of asteroids with Indian names Some foreign astronomers have named the asteroids discovered by them as "Shakuntla", "Shiva" and "Sita". Dr. Richard West of Chile has named one asteroid after the late Dr. Vainu Bapu, the renowned astrophysicist, while Prof. Tom Gehrels of the University of Arizona has called two asteroids "Vikram" and "Mrinalini" after the space scientists Dr. Vikram Sarabhai and his wife.

The first Indian discovery has come more than a century after Dr. Norman Robit Pogson, director of the East India Company's observatory at Madras, found five asteroids between 1861 and 1885. "Asia", "Sappho", "Sylvia", "Camilla" and "Vera" were his discoveries.

## High-speed Electric Car

General Motors Corporation has built an electric-powered car that can race from zero to 100 km per hour in eight seconds and should erase the perception of electric cars as "golf carts", Chairman of the Corporation, Mr. Roger Smith claimed. The two-seater car called the Impact is "on the cutting edge of technology," Mr. Smith told reporters

The car, which officials showed on film outracing a Mazda Miata and a Nissan 300 ZX in an acceleration test on level ground, has a range of 200 km between battery recharges, which could make it a perfect second car for freeway commuters in smoggy cities.

General Motors might need to produce 100,000 of the vehicles a year for them to compete with cars powered by internal combustion engines It is acknowledged that because the car batteries would have to be replaced every 32000 km, it would cost about twice as much to operate similar cars However, advances in technology should extend battery life to 80,000 km within three years

## Black Hole Swallowing up Stars

Scientists say they have made the most detailed look at the centre of the Milky Way galaxy and found what appears to be a massive Black Hole gobbling up one star every 5,000 to 10,000 years. It is 25,000 light years from the earth.

Computer-generated pictures released at the American Astronomical Society meeting show an object one million times the size of the sun that seems to be spinning off what appears to be clusters of gas, said North Western University, U.S.A. astronomer, Farhad Yusef-Zadeh. This is the most detailed look at the centre of our galaxy and it is similar, in a scaled-down version, to what is expected to be seen in the nuclei of active galaxies, claimed Mr. Yusef-Zadeh. Supermassive black holes are believed to be embedded in the centre of these galaxies.

A Black Hole is believed to be an imploded star, a massive object so dense that even light cannot escape its gravitational pull.

"It's an arena where gravity has a complete triumph over all other forces," the scientist said of his research that involved three years of observation through a very large array of radio telescopes.

The pictures of the object, called Sagittarius-A, show at least seven clumps of gas surrounding it and seeming to spiral outward from it, as if being sprayed out from something rapidly spinning

Until now it had not been clear whether Sagittarius-A or a star cluster called IRS-16 was really at the centre of the galaxy. He believed that he had good evidence that Sagittarius-A is truly at the centre of our galaxy and was responsible for energizing its immediate vicinity

## "RNA Editing" Can Cure Many Diseases

Biologists have made a startling discovery that some chemical messages sent by genes are changed before they arrive at their destinations, a finding that challenges the central tenet of genetics.

Mr. Larry Simpson of the University of California, Los Angeles, a co-discoverer of the phenomenon said, it could lead to new treatments for the African sleeping sickness, a similar south American ailment called Changes' disease, and leishmaniasis (a disfiguring skin disease), all caused by the *Trypanosoma* group of parasites.

The first evidence of the process, called "RNA Editing", was found in Trypanosomes by Rob Benne of the University of Amsterdam, in 1986. RNA Editing has since been found in a slime mould called *Physarum*, in measles virus, and in the human gene for protein called Apolipoprotein B, associated with heart disease.

Independent teams in France and Canada reported in *Nature* magazine that they had discovered RNA Editing in wheat plants. "It's an absolutely astounding concept," said Mr. Clive Uhlenback of the University of Colorado in Boulder. "Nobody has the foggiest idea how it works," he added.

Researchers do not yet know how widespread RNA Editing is or why it evolved, but it appears to be a normal part of the functioning of some genes In Trypanosomes, for example, researchers found that certain genes had some crucial elements present in the genetic messenger chemical associated with those genes.

RNA Editing is the name that researchers gave to the process by which the missing elements were restored

## Advance in Artificial Retina Research

Toshiba Corp. has created the world's first prototype of an artificial retina, paving the way for developments of highly sophisticated optical products and computers.

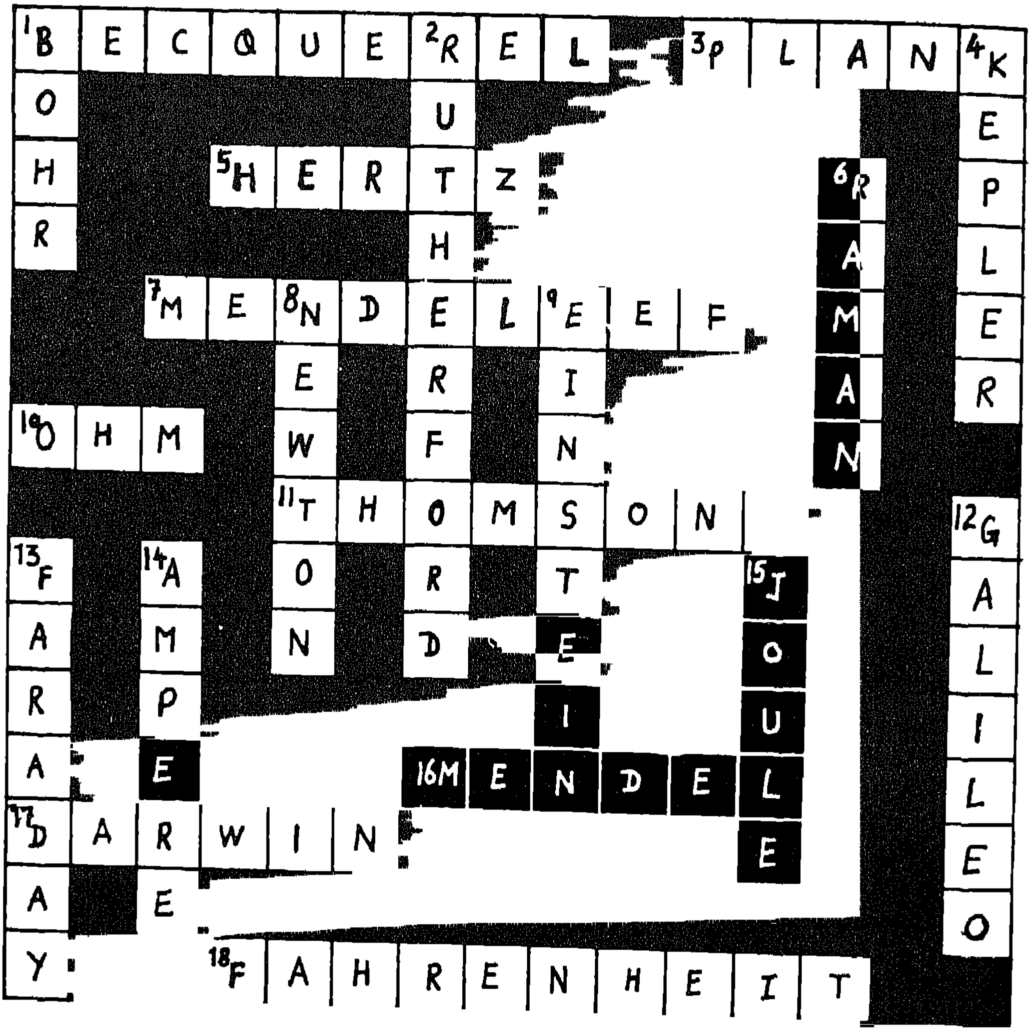
Toshiba's retina-like membrane, developed not for commercial sales but as a result of the company's basic research, is capable of transforming optical signals into electric pulse signals in a way similar to the way the human retina's molecular structure changes when exposed to light, said an official of the company.

They could signal future advances in the development of aids for those with poor eyesight. If such signals are somehow transmitted to a human brain through the nervous system, it can be applicable to patients with weak eyesight But that will take at least a few decades. It is predicted that application to computer systems and lenses for video camera would come earlier than its medical use.

## Forest Cover Dwindling

Environmentalists and administrators are perturbed over recent reports that India's forest cover was rapidly dwindling. Government of India's Report of 1989 based on visual interpretation of Landsat imagery during 1985-87 has said that the Orissa's total forest cover of 53,163 sq. km in 1981-83 has shrunk to 47,137 sq km by 1985-87. This was the highest forest loss in the country during the period, followed by Maharashtra (3,358 sq. km) and Andhra Pradesh (2,283 sq. km).

The report said that while forest loss in States like Haryana, Kerala and Maharashtra was not real and the difference was due to over-estimations made earlier, the losses in Orissa were real. Over 400 sq. km of forest was destroyed in the hilly Koraput district of Orissa alone and the rest



of the change had resulted from degradation of open forests to scrub lands due to the shifting cultivation. According to the first recorded figures, Orissa had a forest cover of 59,555 sq. km, 38.2% of the total area of 155,780 sq. km.

Since the last survey, some states have had impressive gains in increasing forest area. Arunachal Pradesh topped the list with an increase of 8,263 sq. km. Madhya Pradesh, which had a fifth of the country's total forest area, added 5,442 sq. km to its existing forest land. Uttar Pradesh followed with 2,401 sq. km, the report said.

Environmentalists in Orissa, however, were more upset over figures provided by the State-run Orissa Remote Sensing Application Centre based on visual interpretations of Landsat data. The Centre's report said that the total area under forest cover in Orissa amounted to only 39,425 sq. km when the study was undertaken towards the end of 1981. It said that the total area under closed forest was 28,812 sq. km, that under open degraded forest was 10,386 sq. km and mangrove forest (the Bhittar Kanika Mangrove Forest in Cuttack district) 227 sq. km.

The study pointed out that within a period of seven years, the total reduction in the area under closed forest was 8,508 sq. km, that under open degraded forest was 443 sq. km and under mangrove forest, 7 sq. km. It also said that the projected figures of forest area in the State by 2000 A.D. would be 16,731 sq. km, accounting for a meagre 10.74% of the total area.

A senior Government official pointed out that the loss of forest over such a large area was not actual. "Now our apprehension about large denuded areas being shown as forest on paper has come true. The satellites have bared the truth," he said.

The official agreed that the Government's efforts at afforestation had been inadequate as the loss of trees far outstripped the plantation programme. While the Government departments and agencies were able to undertake plantation on 50,000 hectares in the State at an annual cost of Rs. 30 crore the forest loss was estimated at 150,000 hectares.

Besides the State Forest Department, the social forestry scheme launched with the Swedish International Development Agency, the Orissa Plantation Development Corporation, the Soil Conservation Orissa Forest Corporation and the Similipahar Forest Development Corporation were engaged in the programme.

It has now become clear that instead of trying to plant entire forests, it would be more prudent to provide protection to denuded forests and allow them to regenerate. This would make more economic sense.

The report states that when classified on the basis of actual forest cover, all the States except the north-eastern hill States, Goa, Andaman and Nicobar Islands, besides Nagar Haveli had less forest cover than stipulated in the national forest policy.

The situation was much worse in Gujarat, Haryana, Jammu and Kashmir, Punjab, Rajasthan, West Bengal, Daman and Diu, Chandigarh and Delhi where the forest cover was less than 10% of the area.

# Book Review

## Physical Paradoxes and Sophisms

V.N. Lange (Author of Original Russian Edition)
Mir Publishers, Moscow, USSR (1987)

A paradox is a statement that appears to contradict common sense, yet it is founded on truth. In a way a paradox means 'believe it or not, it is true'. In Physics the *hydrostatic paradox* is well known. There is a simple model consisting of three vessels of different shapes and sizes interconnected at the bottom and held vertically which is demonstrated often by the teachers only to show this interesting paradox without explaining it. It is interesting to know that it had baffled even the famous French physicist Blaise Pascal (1623-1662), but was properly explained by the Dutch scientist Siman Stevin (1548-1620). The book under review, *Physical Paradoxes and Sophisms* not only brings out the fallacy involved in this paradox (described under number 1.42 at pages 46-48) but also gives the origin of the paradox under the solutions. A large number of interesting paradoxes are included in Part 1 of the book and their solutions are given in Part 2.

It is worthwhile to mention that mathematicians and eminent scientists like Leibnitz, Euler, and Einstein understood the important role of puzzles in the form of paradoxes and sophisms. It is said about Einstein that it was his early love of original problems/puzzles that developed his striking ability for thinking which was unusual and that is what led to the great contributions made by him.

Sophism (a Greek word) refers to an argument which is correct apparently but actually contains an error that makes the final deduction absurd. A common example of sophism is

> That which you didn't lose, you possess
> You have not lost horns, hence you possess them

A typical example of a sophism in physics taken from the book (under the number 1.5 at page 15) is briefly discussed below.

If one is asked to give the average velocity of a motorcyclist who moves from point $A$ to point $B$ at 60 km/h and returned along the same path at 40 km/h; of course it has to be for the total travelling time minus the time for which the motorcyclist stopped at the point $B$. By intuition the usual answer given is 50 km/h, which is incorrect as can be seen from the calculation that follows.

Let $l$ be the distance between $A$ and $B$, and $t_1$ the time taken for going from $A$ to $B$ at a speed $v_1$, and further $t_2$ and $v_2$ for the return journey by retracing the path. The total time $t$ will be

$$t = t_1 + t_2 = \frac{l}{v_1} + \frac{l}{v_2} = \frac{l\,(v_1 + v_2)}{v_1 v_2}$$

Thus average speed

$$(v_{av}) = \frac{2l}{t} = \frac{2l\,l\,(v_1 + v_2)}{v_1 v_2} = \frac{2 v_1 v_2}{v_1 + v_2}$$

So by substituting the values of $v_1$ and $v_2$ we get

$$v_{av} = 48 \text{ km/h}$$

The equation for $v_{av}$ can also be written as

$$\frac{1}{v_{av}} = \frac{1}{2}\left(\frac{1}{v_1} + \frac{1}{v_2}\right)$$

which shows $v_{av}$ to be the harmonic mean of $v_1$ and $v_2$.

The book has a good collection of very many paradoxes and sophisms spread widely over the different sections of physics like: (1) Mechanics, (2) Heat and Molecular Physics, (3) Electricity and Magnetism (4) Optics and Atomic Structure. Some interesting ones are: 1.15 Was Aristotle Right? 1.22 The Enigma of Universal Gravitation Forces, 1.27 The Paradox of Rocket Engines, 1.43 A Physicist's Error, 2.1 Do Sunken Ships Reach the Bottom? 2.18 Why Does Water Evaporate? 3.1 Is Coulomb's Law Valid? 3.30 A Strange Case of Magnetization, 4.4 An Uncommon Mirror, 4.15 Instead of a Laser, 4.17 What is the True Colour? 4.21 The Paradox of Rulers

The book is likely to help the readers (including students and teachers) to avoid some of the common mistakes and to overcome confusion about certain phenomena. It seems mainly for this reason that the book got translated into several languages including German and Japanese. It spreads the message

"When in doubt seek the truth"

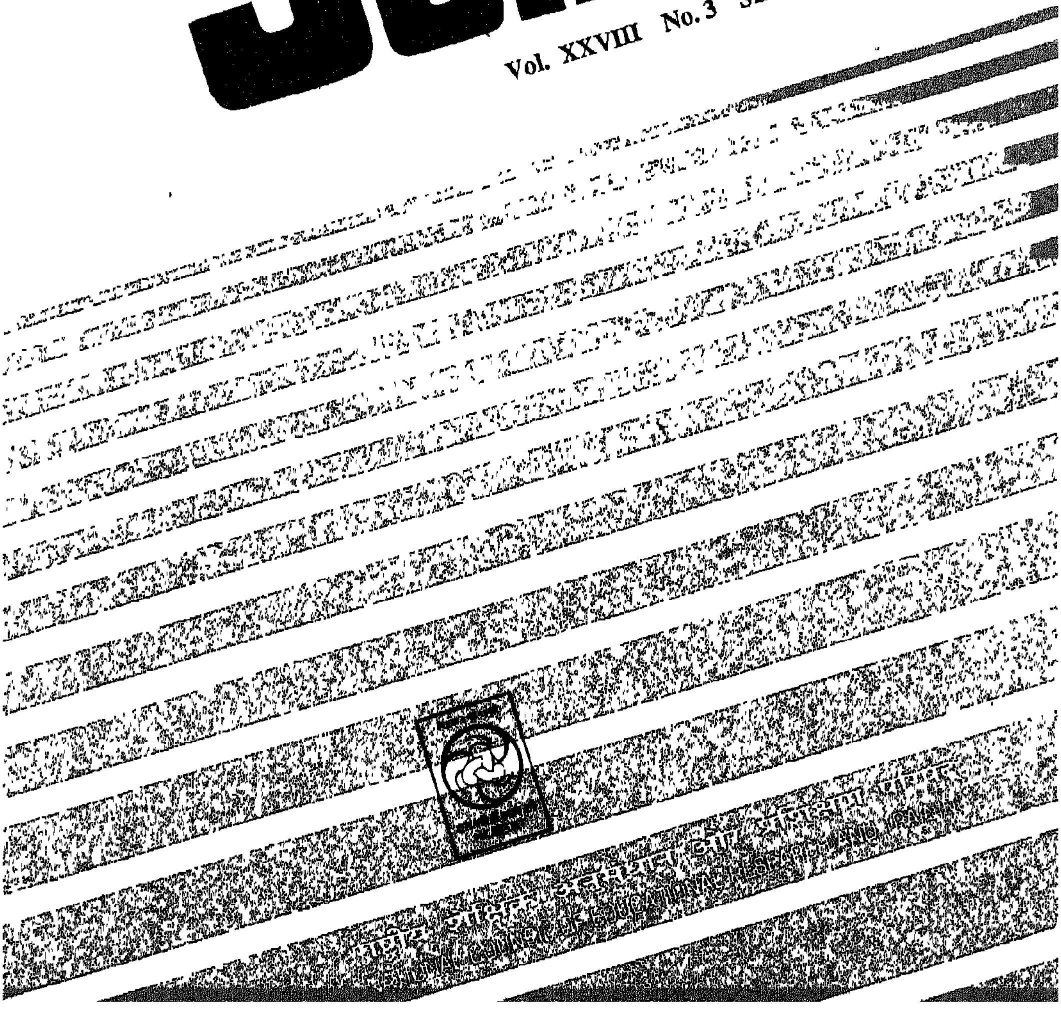
However, the language is far from satisfactory. Moreover, the readers should be mentally prepared to come across the common Russian terms and phrases reflected in the description such as Nautilus (name of a submarine). Nevertheless they will certainly find the content of this book of 232 pages to be not only interesting but absorbing and gain a good deal from it and develop a scientific way of thinking.

Looking to the large number of puzzling situations so well described with suitable solutions given in Part 2 in the same book, it would certainly prove highly useful for libraries in general and for educational institutions in particular.

K.J. KHURANA
*DESM, NCERT, New Delhi*

# SCHOOL SCIENCE

Vol. XXVIII No. 3 SEPTEMBER 1990



राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

SCHOOL SCIENCE is a quarterly journal published by the National Council of Educational Research and Training. Intended to serve teachers and students in schools with the recent developments in science and science methodology, the journal aims to serve as a forum for the exchange of experience in science education and science projects Articles covering these aims and objectives are invited. Manuscripts, including legends for illustrations, charts, graphs, etc. should be neatly typed double-spaced on uniformly-sized paper, and sent to the Editor, SCHOOL SCIENCE, Department of Education in Science and Mathematics, NCERT, Sri Aurobindo Marg, New Delhi 110 016. Each article may not normally exceed ten typed pages.

The articles sent for publication should be exclusive to this journal.

Illustrations may be limited to the minimum considered necessary, and should be made with pen and indelible [illegible] on glossy paper, at least of postcard size, and should be sent properly packed [illegible]

## EDITORIAL ADVISORY COMMITTEE

*Chairman*
Dr. K Gopalan
Director
NCERT, New Delhi

*Members*
Prof. A.K. Sharma
Joint Director
NCERT, New Delhi

Shri J. Veeraraghavan
Special Secretary, Ministry of Human Resource Development
Govt. of India, New Delhi

Prof. Satya Bhushan
Director
National Institute of Educational Planning and Administration
New Delhi

Additional Secretary
Ministry of Human Resource Development, Govt. of India
New Delhi

Prof. M.R. Bhide
Poona University
Pune

Prof. Rasheeduddin Khan
Jawaharlal Nehru University
New Delhi

Prof. L.S. Kothari
University of Delhi
Delhi

Prof Durgananda Sinha
Former Director
A.N. Sinha Institute of Social Studies
Patna

Prof. R.N. Ghosh
Central Institute of English and Foreign Languages
Hyderabad

Prof Namwar Singh
Jawaharlal Nehru University
New Delhi

Dean (Academic)
NCERT, New Delhi

Dean (Research)
NCERT, New Delhi

Dean (Coordination)
NCERT, New Delhi

Shri C N. Rao
Head, Publication Department
NCERT, New Delhi

Head, Department of Teacher Education, Special Education and Extension Services
NCERT, New Delhi

Prof. B. Ganguly
Head, Department of Education in Social Sciences and Humanities
NCERT, New Delhi

*Convenor*
Prof. R.P. Singh
Head, Journals Cell
NCERT, New Delhi

## EDITORIAL GROUP

Chief Editor: B. Ganguly, General Editor: R.P. Singh, Executive Editor: D. Lahiry
Members: R.C. Saxena, K M. Pant, Rajendra Joshi, J.S. Gill
Editor: G.L. Anand, Chief Production Officer: U. Prabhakar Rao
Production Officer: D Sai Prasad, Production Assistant: Rajendra Chauhan
*Cover Design*: D.K Shende

## SUBSCRIPTION

*Annual:* **Rs 16.00** *Single Copy:* **Rs 4.00**

A QUARTERLY JOURNAL
OF SCIENCE EDUCATION

Vol. XXVIII No. 3
September 1990

# SCHOOL SCIENCE

## CONTENTS

| | | |
|---|---|---|
| Probing Scientific Creativity among Youngsters: Need for an Operational Tool | 1 | C. SINGH |
| Basic Concepts of Environmental Education | 5 | |
| Futurism in the Science Curriculum | 10 | MARLOW EDIGER |
| Balancing Chemical Equations by High School and College Students, and Pre-service Science Teachers | 15 | A. C. PACHAURY |
| Scanning Genes for Heart Disease | 21 | JOHN NEWELL |
| Models Approach to the Teaching of Biology | 27 | BHARATI BAVEJA |
| Women in Science and Technology | 34 | SURJA KUMARI |
| The Role of Experiments and Improvisation in Effective Teaching of Physics at +2 Stage | 37 | O.P. SHARMA<br>K J. KHURANA |
| A Study of Order of Preference for Circuit Diagrams in Physics by Secondary School Students | 41 | LALIT KISHORE<br>H.S. PURI |
| Science News | 45 | |
| Crossword Puzzle | 51 | |
| Book Review | 53 | |

## TO OUR CONTRIBUTORS

*School Science* invites articles from teachers, acquainting students with the recent developments in science and science methodology. The articles should be addressed to Executive Editor, Department of Education in Science and Mathematics, NCERT, Sri Aurobindo Marg, New Delhi 110 016.

# Probing Scientific Creativity among Youngsters: Need for an Operational Tool

C Singh
A-347, Sector 19
Noida 201 303 (U.P.)

*A test for measuring scientific creativity should search for novelty in all the abilities required by a scientist. This approach appears to have been endorsed in the Russian model of thinking process of a scientist in the moment of discovery.*

In this age of science and technology, the world is changing fast. All the countries faced with the resulting challenge of such change are struggling hard to tackle it. The nations endowed with creative persons are able to effectively overcome this problem. 'Creativity' has, therefore, acquired a crucial role in the life of all the nations. In other words, from the point of view of survival, the identification of creative potential and its proper nurture among the people has become a matter of paramount significance for every nation. Thus, the need for early identification of creative youngsters and their careful grooming appears to be imperative for every nation. Now, the question arises: how to identify creative potential among youngsters? A reasonable approach in this regard would be to analyse the concept of creativity.

## A Complex Concept

The word 'creativity' has been used in different ways by people in different walks of life.

According to Ghiselin, B. (1963), Flagan, J C. (1963) and Stein, M I. (1963), a creative product must be an intrinsically new product without specific precedent. But in the opinion of Prof. John H. Arnold as quoted by Whiting Charles (1958), Bruner (1962), Mednick (1962), P.A. Murray as quoted by Herbert (1963) and Bybee (1972), a creative product should not be only novel but also be desirable, useful or satisfying to a group at a point of time.

Thurstone (1962) appears to differ from others on the notion of novelty in creative product. While endorsing the view that creativity leads to the new and desirable products, he emphasizes the point that the product may be new either to the society or merely to the individual.

Creativity is, thus, thought of in two ways. To some, creativity is the production of new ideas never before known to man. Others consider it as a novel product or process which may not be new to society but would be so to the individual.

Another area of confusion in the concept of creativity is the tendency of many persons to confuse craftsmanship with creativity. A man may be just an excellent craftsman who follows traditional pattern and thus produce nothing creative.

Mednick (1962), Wallach and Kogan (1965) and Bybee (1972) further appear to endorse the view that creative idea is a triggered synthesis resulting from the interaction of two or more ideas not previously related

In the opinion of Guilford (1962), abilities of *divergent production, transformation* and *sensitivity to problem* are closely linked with creativity In fact, it is the relative variety and novelty found in divergent production which links this category of ability with creativity.

Torrance, E P. (1962) is of the view "Creativity is the process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, forming ideas or hypothesis and communicating the result, probably modifying and retesting the hypothesis."

In view of the above discussion, creativity turns out to be a complex concept defying all attempts to define it precisely. In spite of this difficulty, researchers in the field of creativity have not been deterred in their attempts to develop creativity-tests.

### Existing Creativity-Tests

There are three major categories of creativity-tests: Guilford-tests, Torrance-tests and Wallach-Kogan's tests. In fact, the latter two are the modification or extension of the first one. While the Guilford-tests based on his three dimensional model of *Structure of Intellect* are said to be suitable for junior high school through college and adults levels, Torrance-tests have been claimed to be applicable right from Kindergarten to post-graduate students. However, Wallach and Kogan (1965) have pointed out that Guilford-tests and Torrance-tests suffer from the defects of weaker correlations among their own different sub-tests in comparison to the correlation between the creativity-tests concerned and IQ-tests and, therefore, appear to be slightly different from IQ-tests.

Not satisfied with these tests, Wallach and Kogan designed their own battery of tests. Though, their battery is heavily dependent upon Guilford's battery, they claim it to be free from the shortcomings of Guilford's and Torrance's tests due to different administration procedures which they consider to be of crucial importance. However, Guilford (1971) has adversely commented on Wallach-Kogan's tests on several accounts. According to him, the use of liberal time by the subjects is likely to affect the character of the test and the variables that it measures. With respect to the playful atmosphere, he is of the opinion that test is a test even when it is called a game. Further, the relaxation expected to be experienced by the child in a game-like situation is largely counteracted by the conditions of individual testing with the tester present and taking notes. He further argues that due to unrestricted time available to the subjects, Wallach and Kogan's test-scores should correlate higher with IQ-scores than do customary DP test-scores but it does not happen. Thus, it is an indirect evidence against the conclusion that Wallach and Kogan's tests measure anything creative.

It is evident from the above discussion that there exists a great deal of controversy regarding the efficacy of the above creativity-tests Failure of these creativity-tests is perhaps caused by a number of reasons like an inappropriate criterion, a poor selection of abilities to be tested, or low reliabilities of criteria or of tests or of both.

### Assessing Scientific Creativity

There is a general belief that differentiating scientific creativity from general creativity is not needed and, therefore, the tests developed for measuring general creativity can be used for assessing the scientific creativity as well. However, this belief is not shared by some researchers according to whom, scientific creativity has some specialities of its own which are different from the creativity in other areas.

Hadmard (1945) has pointed out that the distinguishing characteristic of science is to relate the facts of investigation and to weave them into a comprehensible whole It is a unique attribute of science and is generally not applicable to other areas of activities.

Singh, C. (1976) is also of the opinion that scientific creativity appears to be very much different from creativity in other areas. As an example, for a poet to be creative, he must be highly imaginative. The abundance of fantasy is the prime requisite for him So is the case with an artist. On the contrary, mere imagination and fantasy alone will not be of much help to a creative scientist. Though speculation and bold guess are sometimes needed by a creative scientist to solve his problem, but this alone will leave him in complete wilderness leading nowhere near his goal. To achieve something novel, creative out of his speculation, he must be capable of observing minutely, analysing, elaborating and generalising. A test for measuring scientific creativity should, therefore, search for novelty in all the abilities required by a scientist. This approach appears to have been endorsed in the Russian model of thinking process of a scientist in the moment of discovery. From the above discussion, it becomes obvious that while developing a tool for measuring scientific creativity, the process involved in a scientific enquiry must be properly dovetailed to the factors identified to be clearly linked with creativity.

In short, a scientific creativity-test should not be constructed out of divergent production factors alone. It must contain an element of convergent production too. Bruner (1962) and Pirbram (1964) also appear to hold somewhat similar view. According to them, creative production results only when boundaries of the known are first mastered through convergent process and then extended by the application of divergent process. Further, the tool so developed must also be operationally effective for use among youngsters. This can be ensured if the abilities selected for test among youngsters are normally demonstrable by them as well as adequately measurable.

## References

1. Bruner, J.S. "The Creative Surprise" in Gruber, H.E., Terrel, G. and Wertheimer, M. (eds.) *Contemporary Approaches to Creative Thinking*. New York: Atherton Press, 1962.
2. Bybee, Rodger W. "Creativity, Children and Elementary Science", *Science and Children*, 1972, 9.
3. Flagan, J.C. "The Definition and Measurement of Ingenuity". In Taylor, C.W. and Barron, F. (eds.), *Scientific Creativity: Its Recognition and Development*. New York: John Wiley and Sons, Inc., 1963.
4. Fox, H. Herbert. "A Critique on Creativity in Science" in Coler, M.A. (ed.) *Essays on Creativity in Science*. New York: University Press, 1963.
5. Ghiselin, B. "Ultimate Criteria of Two Levels of Creativity", in Taylor, C.W. and Barron, F. (eds.), *Scientific Creativity: Its Recognition and Development*. New York: John Wiley and Sons, Inc., 1963.
6. Guilford, J.P. "Potentiality for Creativity", *The Gifted Child Quarterly*, 1962, 61.
7. Guilford, J.P. "Some Misconceptions Regarding Measurement of Creative Talents", *Journal of Creative Behaviour*, 1971, 5 (2).

8. Hadmard, J *The Psychology of Invention in the Mathematical Field.* London: Oxford University Press, 1945.
9. Mednick, S.A. "The Associative Basis of Creativity", *Psychological Review*, 1962, 69.
10. Pirbram, K.H. "Neurological Notes on the Arts Education" In Hillgard, E.R. (ed.), *NSSE Year Book LXIII*. Chicago: University of Chicago Press, 1964.
11. Singh, C. *Scientific Creativity Test for High School Students.* Unpublished Doctoral Dissertation, University of Ranchi (India), 1976.
12. Stein, M I. "A Transactional Approach to Creativity", in Taylor, C.W. and Barron, F. (eds,) *Scientific Creativity: Its Recognition and Development.* New York: John Wiley and Sons, Inc , 1963.
13. Thurstone, L.L. "Creative Talent", in Thurstone, L.L. (ed.), *Application of Psychology.* New York. Harper and Brothers, 1952.
14. Torrance, E.P *Guiding Creative Talent.* Englewood Cliffs, N J.: Prentice Hall, 1962
15 Wallach, M.A. and Kogan, N. *Modes of Thinking in Young Children.* New York: Holt, Rinehart and Winston, 1965.
16. Whiting, Charles S. *Creative Thinking*. New York: Reinhold Publishing Corporation, 1958.

# Basic Concepts of Environmental Education

---

*This article, in condensed form, is almost wholly based upon a publication of the United Nations Environment Programme, conceived as a contribution to the EE series of the UNESCO-UNEP International EE Programme· Donella Meadows'* ***Harvesting One Hundredfold: Key Concepts and Case Studies in Environmental Education.*** *Copies are available by writing to UNEP, P.O Box 30552, Nairobi, Kenya.*

---

Though local, national and regional environments vary, the basic concepts of environmental education are applicable everywhere. They are the core, the primary themes that environmental educators endeavour to communicate universally They apply to citizen and decision-maker alike They are as basic as caring for one's room and one's health, one's home, school yard or farm yard, and they are as sophisticated as caring about global warming and climate change, the torching of rain forests, acid photochemical fog, land management and urban planning; because they deal concretely with the quality of everyday life, today and tomorrow.

Listing key environmental concepts in a logical order can be misleading, since the very process of categorization violates one of the concepts—namely, that the world, the environment, is a whole, that everything is interconnected. No categorization of life's great variety can be regarded as complete, nor the assignment of definitive priorities. That said, a list of key concepts of environmental education (based on a brochure described in the beginning of this article) follows herewith. The environmental educator is invited to add to it, rearrange it, join in the vitalizing search for the most fundamental things to learn and to teach about the wondrous complex system we call our Planet Earth.

### A. Levels of Being

1 There are three distinct levels or systems of being, social, biological and physical, each of which obeys its own laws plus those of all lower levels. They are, in reverse order: (a) the physical planet, its atmosphere, hydrosphere (waters), and lithosphere (rocks and soils), all of which obey the laws of physics and chemistry; (b) the biosphere, all living species, which obey the laws of physics, chemistry, biology and ecology; (c) the technosphere and sociosphere, the human created world of buildings and machines, governments and economies, arts and religions and cultures, which obey physical, chemical, biological and ecological laws, and also further laws of human devising.

An example of a *physical* law obeyed by all these levels of existence is the law of entropy, the Second Law of Thermodynamics Because of entropy machines slowly wear out. It takes outside energy to make or repair or heat a machine; and that withdraws useful energy from elsewhere. An example of a *biological* law applicable to all forms of life is that the chemical composition and organization of any individual is determined by the genetic code carried on the long molecules called DNA within every cell. *Human generated* laws regulating societies and economies are immensely varied and changeable cording to time and circumstance. Underlying them are the relatively unchangeable biological, chemical and physical laws.

2. Since all environmental phenomena obey the same underlying physical laws, they behave much the same everywhere, although their complexity can lead to enormous local variation

Similarity and difference, common physical laws and great variety in the manifestation of those laws—these opposites characterize the planet. Environmental education (EE) emphasizes the underlying regularities, while maintaining respect for the different ecosystems and human cultures of the earth. That double duty to recognize the global similarities while effectively interacting with the local specificities is summarized in an effective EE slogan: Think globally, act locally.

3. The various levels of being—physical, biological and social—operate on very different time-scales, which can make management difficult.

It has taken millions of years for the species of life now on earth to evolve, because of human destruction of their habitat alone, about one species a day becomes extinct. It takes about 300 years to form 3 centimetres of good topsoil; bad farming can remove that soil within ten years; one violent storm or flood on unprotected land can remove it in hours.

4. The levels of being are distinguished by profound and mysterious qualities. life, consciousness and self-awareness. Human beings are considered to be the only creatures that possess, perceive and appreciate all these qualities, which gives them a special responsibility for stewardship of all the levels of being.

**B. Cycles**

1. Matter cannot be created or destroyed. The material of the planet stays on the planet, undergoing continuous transformations, powered by the energy of the earth and sun.

As environmentalists say: "There is no such thing as a free lunch." "Everything goes somewhere." "There is no Away to throw things to." In other words, *materially* the earth is a nearly closed system? Transformations must come from combinations of the matter already there. *Energetically*, however, the earth is an open system. It receives constant energy from the sun, which it must re-radiate back out into space in order to maintain a controlled temperature.

2. The materials necessary for life—water, carbon, oxygen, nitrogen, etc.—pass through biogeochemical cycles that maintain the purity and the availability of these materials for living things.

Human beings are just beginning to learn how to design a complex, modern, high-productivity industrial economy that follows the planetary requirement of cycling. Organic wastes from crops and cities can be composted and returned to the soil. Metals, paper, glass, plastics and exotic chemicals can be reclaimed, refabricated and reused, often at great economic and environmental benefit.

3. The biogeochemical cycles combine to form a complex control mechanism that maintains conditions hospitable for self-maintaining, living organisms.

Those control mechanisms are mediated by life itself. That is, the living organisms on the earth's surface, especially the micro-organisms, by their biochemical functioning and their population expansions and contractions, keep the earth's atmosphere, and hence its surface temperature, regulated. Furthermore, they hold the atmosphere in an anomalous composition of gases, far different from those that would be found in chemical equilibrium on a lifeless planet. (Deterioration of the protective ozone layer results by and large from destructive human inputs.)

The "greenhouse effect" is an example of disturbing the natural control mechanism. It results from careless pouring of such industrial and other gases as carbon dioxide, nitrous oxide, chlorofluorocarbons and methane into the troposphere in such quantities as to create a "blanket" trapping heat radiating from the ground with the consequence of the current "global warming" and climate change.

The threat is contained in these estimations: if the temperature of the earth rose by just 5 to 6 degrees, the polar ice would melt, the levels of the oceans would rise, large coastal areas of the continents would be flooded and rainfall patterns would change everywhere Most species of life would have to either migrate or die.

4. The natural forces propelling the planetary cycles are enormous compared to human forces. They perform priceless services. They are easier to work with than against.

Examples abound: micro-organisms, sunlight and oxygen clean up millions of tonnes of organic wastes in rivers; natural predators control far more crop pests than human-devised pesticides do, and they do not leave a residue of poison behind, etc.

### C. Complex Systems

1. Everything is connected to everything else.

Think of the world as organized into systems which consist of three components: elements, interconnections and a function or purpose.

2. Systems are more than the sum of their parts; they are dominated by their interrelationships and their purposes.

3. Systems are made up of interconnected stocks and flows. The stock/flow configurations of nonrenewable and renewable resources are different; therefore these two kinds of resources need to be managed differently.

4. Systems are organized into *hierarchies*, which means that everything is connected to everything else, but not equally strongly.

5. Natural systems are finely tuned, stable and resilient. Diversity usually increases this resilience.

### D. Population Growth and Carrying Capacity

1. Populations of living organisms tend to grow exponentially, when they are able to grow at all.

One bacterium divides into two. The two divide into four. After ten divisions there are over 1,000 bacteria. After twenty, there are over one million. Every population has this potential to grow explosively, *exponentially*.

2. The limit to the rate of production of any renewable resource base puts an upper boundary, called the *carrying capacity*, on the number of organisms that can be sustained on that resource base.

The carrying capacity for human life and society is complex and *dynamic*: it moves up and down, depending on how well human beings manage their environment.

3. The carrying capacity is defined by its most limiting, not its most abundant, component. It is like a chain whose strength is determined by its weakest link.

4. Carrying capacities can be enhanced or degraded by human activity.

5. Efficient use of resources—doing more with less—increases the number of people that can be carried on a resource base.

6. Restoration of a degraded carrying capacity is far more difficult than preservation; prevention of damage is cheaper than the cure.

### E. Environmentally Sustainable Development

1. Human wealth and economic development ultimately derive from and depend upon the resources on the earth. Sustained development is

simply impossible if environmental degradation is allowed to continue.

2. The earth's resources are sufficient for all living creatures' needs, if they are managed efficiently and sustainably. There should be enough soils, waters, materials and energy to meet the basic needs of at least one more population doubling on earth, *if* those resources are wisely managed and equitably distributed.

3 Both poverty and affluence can cause environmental problems.

4. Economic development and care for the environment are compatible, interdependent and necessary. High productivity, modern technology and economic development can co-exist with a healthy environment *They must co-exist*, or the development will not be sustainable or humanly livable.

### F. Socially Sustainable Development

1. The key to development is the participation, organization, education and empowerment of people. Sustainable development is not production-centred; it is people-centred.

2. Sustainable development must be *appropriate* not only to the environment and resources but also to the culture, history and social systems of the place where it is to occur. Appropriate technology is a demonstration of this.

3. Development must be equitable, fair. No social system can be sustainable over the long term when the distribution of "goods" and "bads" within it is grossly unjust, especially when some part of the population is consigned to chronic debilitating poverty.

4. Development involves the continuous balancing of opposites and the breaking down of barriers and separations between freedom and order, groups and individuals, work and leisure, settlements and nature.

Production does not need to be organised in a way that endangers or diminishes people. Cities do not need to be designed to exclude nature. Societies can be orderly while individuals have freedom. Machines can enhance the expression of creativity and humanity without oppressing, demeaning or physically harming the people who work the machines. People can see themselves as both part of nature and ultimately responsible for nature.

### G. Knowledge and Uncertainty

1. We don't fully understand how the world works; we don't even understand how much we don't understand.

Example: There are about 400 nuclear power plants in the world, each producing radioactive wastes with half-lives of up to 24,000 years. Nuclear technology has been pursued as if someone knew with great certainty how to protect those plants from catastrophic failure, how to decommission them safely when their productive life is over, how to keep their wastes from the biosphere and hydrosphere for tens of thousands of years. We are proceeding under an assumption of much greater knowledge than we actually have, and the risk in case of failure is tremendous.

2. We make decisions under grave uncertainty. When the results can be devastating and irreversible, we must manage the risks very carefully.

3. In a situation of uncertainty, the appropriate procedure is careful assessment and slow experimentation, followed by constant, truthful evaluation of results and willingness to change strategies.

### H. By Way of a Conclusion

A healthy, beautiful environment is not a luxury, it is a basic human need, both materially and non-materially.

"A clean and beautiful environment" was listed by members of Sri Lanka's Sarvodaya Shramadana movement as the first of ten basic human needs. The others: a clean and adequate supply of water; simple clothing, food, health care; communications (does this subsume human relations, physical and other?); simple housing; energy requirements; total education; spiritual and cultural needs.

Besides "basic human needs," the Sri Lanka popular movement eloquently, but with remarkable simplicity, instructs us by its example as to what can be meant by "basic environmental education." A village self-help activity, the Sarvodaya Shramadana movement began among the nation's poorest people In one year it built eight times as much roadway as the government, at one-eighteenth the cost, while it was also building schools and houses and irrigation canals. Here is a glimpse of how it was done.

A village joins the movement by inviting a team of Sarvodaya organizers to visit (there are over 27,000 full-time organizers). A meeting is called in the temple, church or mosque, and the people talk about what the village most needs Then the planning begins, with everyone participating.

"You say you have waited two years for the government to clean that canal? You can keep on waiting while your fields bake. But where is your own power? Your power is not in Colombo (capital of Sri Lanka), it is in your heads and hands."

"How can we clean the canal? We have tools but no pans to carry away earth. Is there a substitute for pans? Yes, we can use sheaves of leaves. How many people to do the job? Two hundred, working four days. How many volunteers—can each one bring one other? Right, who will feed them?" A landowner volunteers to supply food. The canal is finished, not in four days but in the afternoon of the first day, and the people are ready to take on the next job

Through "basic environmental education" like that, in many parts of the world forests are being planted, checkdams erected to prevent erosion, clean water systems created, enterprises started, all with little money and few resources except the crucial resource of organized, empowered, learning-while-doing people.

Courtesy: *Connect*

# Futurism in the Science Curriculum

MARLOW EDIGER
**Division of Education**
**Northeast Missouri State University**
**Kirksville 63501, U.S.A.**

---

*Each science teacher should provide for individual differences in the classroom to provide the best science curriculum possible for students. Inservice education in its diverse manifestations may well assist each science teacher to do the best possible in teaching-learning situations*

---

Science educators need to study the objectives, learning opportunities, and appraisal procedures in the present science curriculum. The science curriculum is then being evaluated and described in terms of what exists presently in ongoing lessons and units of study. Science educators should not stop with describing *what is* in the present curriculum. Rather problems need identification and solutions sought in terms of *what should be* in teaching/learning situations in science Predictions of the future science curriculum is a necessity Science instruction needs to move away from the present to a better future. Futurism and its studies are necessary in order to develop excellence in the science curriculum.

## The Science Curriculum of the Future

The teacher will have more adequate opportunities to determine where a student is in science achievement presently. To start where a learner is achieving and work for optimal continuous student progress is an ideal for the science teacher to follow. A futuristic science programme will emphasize determining a student's entry level of achievement with ordered opportunities for optimal achievement.

Second, better approaches in sequencing student learning will be in evidence, be it a psychological or logical science curriculum. Students then will experience increased success in sequential lessons and units. The lack of ordered learnings will be minimized while appropriate sequence in achievement will be optimalized

Third, learners will perceive increased purpose in learning. Thus, students will accept inherent reasons for acquiring facts, concepts, and generalizations Science teachers will have definite knowledge and skills pertaining to assisting learners to perceive purpose in learning

Fourth, materials and methods of teaching will assist science teachers to secure student interests more effectively. With increased interest in science lessons and units, the student will put forth increased effort to learn. Increased interest in science will make for more effort to attain relevant goals of instruction. Interest and effort will be one and not separate entities.

Fifth, harmonious balance among diverse categories of objectives will be in evidence Knowledge objectives stressing students acquiring vital subject matter will become increasingly salient. Skills ends are equally significant for student attainment. With skills objectives implemented, learners apply content acquired within the framework of knowledge objectives. The last of the three categories of objectives—attitudinal—are the most significant. With quality attitudes, students are positive in their wanting to achieve knowledge and skills ends. Science teachers in the future will become increasingly professional in guiding optimal student progress in knowledge, skills, and attitudes. Improved philosophies, psychologies, and research results will assist teachers to increase learner progress in science

Sixth, new materials and procedures of teaching science will assist teachers to individual instruction more thoroughly. With more knowledge available to teachers in providing for diverse achievement levels, each student regardless of past levels of progress will be guided increasingly to attain as much as possible. Developing, growing, learning and achieving in science lessons will become more optimal for each student.

Seventh, science achievement of essentials will be a lifelong process. Growth in science learning will have no end beyond itself. Achievement is continuous and cumulative. Development in knowledge, skills, and attitudes has no ends in the science curriculum. Knowledge for its own sake as well as for utilitarian purposes will become a goal in science for each person. School and society will both emphasize vitality in its diverse manifestations of lifelong learning in science

Eighth, school and society will increasingly integrate its goals in science instruction. What transpires and occurs in science in the societal arena will provide content in the school curriculum. The realness and reality of scientific phenomena will provide objectives for instruction, learning opportunities to attain objectives, as well as appraisal procedures.

Ninth, more appropriate means to ascertain student attainment in science will be in the offing. These appraisal procedures will appraise not only cognitive learnings, but also skills and attitudes. Skills to be appraised include critical and creative thinking, as well as problem solving Appraising student progress in the attitudinal dimension will include determining the quality of feelings, beliefs, and appreciations of contributions of science.

Tenth, quality inservice means of updating science instruction will be in the offing. Inservice education programmes will be varied, purposeful, and provide for individual needs of science teachers. The major objective of inservice education will be to provide the best possible objectives, learning opportunities, and appraisal procedures in actual classroom teaching situations.

## Inservice Education and the Science Teacher

Each science teacher should provide for individual differences in the classroom to provide the best science curriculum possible for students. Inservice education in its diverse manifestations may well assist each science teacher to do the best possible in teaching-learning situations.

First, a quality professional library needs to be in evidence for science teachers in the school setting: Teacher education textbooks, professional journals for teachers, as well as audio-visual materials need to be available to teachers to benefit from. Science teachers should have time to read and view these materials to update the profession of teaching science.

Second, teachers should attend state and national education conventions devoted to the teaching of science Each teacher needs to attend meetings in conventions which assist to provide quality ends, means, and appraisal procedures for students. Attendance at these meetings for science teachers should be fully funded.

Third, science teachers should be involved in a local school district or in a regional meeting involving a planned series of meetings to improve the curriculum. With interaction among participants, quality science lessons and units should be in the offing. Each science teacher has opportunities to share with others means of improving teaching-learning situations.

Fourth, workshops should be conducted to provide science teachers with opportunities to identify and solve problems in teaching students. A general session with all participating should emphasize teachers selecting problems areas. The general session should be followed by committee endeavours. Here, each participant works on his/her chosen problem(s) to solve in the committee setting. Ample opportunities should be provided for teachers to work on individual tasks, projects, and endeavours. Feedback from committee and individual endeavours should be shared with the general session. Practical situations should be emphasized in the workshop whereby each secures valuable suggestions to improve the teaching of science.

Fifth, faculty meetings conducted within a school should assist in identifying and solving problems related to the general areas of curriculum and instruction. These problems could involve discipline, inductive teaching, inquiry learning, as well as utilizing a variety of materials in ongoing lessons and units. The general areas of curriculum development in terms of problem areas identified should also relate to teaching science in the school setting. Hopefully, solutions decided upon will improve the teaching of science.

Sixth, departmental meetings might be an excellent means in improving the science curriculum. Stimulating discussions on new methods in teaching science should aid in curriculum improvement. Content taught in science also needs appraisal to determine if key generalizations, concepts, and structural ideas are being emphasized in ongoing lessons and units.

Seventh, team teaching is a way of learning from others in the teaching of science. With team teaching, members plan cooperatively objectives, learning opportunities, and appraisal procedures. In large group instruction, each team member may appraise and provide feedback to the teacher teaching students. Quality criteria need to be utilized in the feedback. Small group work as well as individual projects and activities for students provide teaching team members ample opportunities to work with learners in committees as well as in individual endeavours.

Eighth, models in teaching science may come from selected audio-visual materials such as video-tapes, films, filmstrips, and slides. Teachers need to analyze and appraise each method, prior to its implementation in the classroom.

Ninth, student teachers, when assigned, are a source of new ideas, methodology, and content for the regular science teacher. The student teacher and the regular teacher need to plan ends, means, and appraisal procedures cooperatively. Each new approach having quality criteria needs to be tried out in actual teaching situations. Feedback from students provides information as to the effectiveness of new approaches utilized.

Tenth, science teachers need to have paid leaves of absence to secure advanced degrees in their area of expertise on a college/university campus. The advanced degree, be it a Specialist in Education or a Doctorate, should assist the science teacher to become increasingly professional and competent in teaching. Achievement, growth, and development are key concepts to emphasize when a science teacher works on and secures an advanced degree.

## In Closing

A forward looking science programme will emphasize:

1. determining specifically where a student is presently achieving.
2. sequencing learning opportunities for optimal student progress.

3. feelings of purpose on the part of the student for learning.
4 securing the interests of students in ongoing lessons and units
5. emphasizing balance among diverse categories of objectives in teaching-learning situations. Thus, each category of objectives—knowledge, skills, and attitudes—will receive appropriate emphasis.
6. providing for individual differences in order that each student may achieve as much as possible.
7 learning as being lifelong and continuous.
8. integrating school and society.
9 appraising student progress for diagnostic purposes as well as to determine progress of learners.
10 increasing opportunities for inservice education for teachers.

Inservice education opportunities for science teachers will emphasize:

1. quality libraries in the school setting. Content will be readily available for teachers to use to improve the science curriculum.
2. attendance at state or national professional teacher education conventions to improve science teaching.
3. regional meetings convened to develop quality objectives, learning opportunities, and appraisal procedures.
4. workshops emphasizing large group and small group sessions as well as individualized study for participants to solve problems in the teaching of science.
5. faculty meetings scheduled to plan a quality science curriculum.
6. departmental meetings to view present trends in teaching with effort put forth to upgrade the curriculum.
7. team teaching as a means of learning from each other in developing the science curriculum.
8. observation of audio-visual materials to update content and methodology.
9. cooperative planning with an assigned student teacher.
10. work toward an advanced degree in science teaching on a college/university campus.

## Selected References

1. Beane, James A. et al. *Curriculum Planning and Development.* Boston· Allyn and Bacon, Inc , 1986, pp. 241-42.
2. Cruickshank, Donald R. *Teaching is Tough* Englewood Cliffs, New Jersey· Prentice-Hall, Inc , 1980.
3. Ebel, Robert and David A Frisbie. *Essentials of Educational Measurement* Fourth edition. Englewood Cliffs, New Jersey: Prentice-Hall, 1986.
4. Esler, William K. *Teaching Elementary Science.* Belmont, California: Wadsworth Publishing Company, Inc , 1973
5 Friedl, Alfred E. *Teaching Science to Children: The Inquiry Approach Applied.* New York· Random House, Inc., 1972.
6. Gronlund, Norman E. *Measurement and Evaluation in Teaching.* New York: Macmillan, 1985.

7. Henson, Kenneth T. *Secondary Teaching Methods.* Lexington, Massachusetts: D.C. Heath and Company, 1981.
8. Herman, Jerry J. *Developing an Effective Elementary Science Curriculum.* West Nyack, New York: Parker Publishing Company, 1969.
9. Joyce, Bruce and Marsha Weil. *Models of Teaching.* Third edition. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1986.
10. Joyce, Bruce et al. *The Structure of School Improvement.* New York: Longmans, 1983.
11. Kuslan, Louis I. and A. Harris Stone. *Teaching Children Science: An Inquiry Approach.* Belmont California: 1972.
12. Lewis, June E. and Irene C. Potter. *The Teaching of Science in the Elementary School* Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1970.
13. Mehrens, William A. and Irvin J. Lehmann *Measurement and Evaluation in Education and Psychology.* Third edition. New York: Holt, Rinehart and Winston, 1984, pp. 14-15.
14. National Society for the Study of Education. *Staff Development,* Part II. Chicago, Illinois: The Society, 1983.
15. National Society for the Study of Education. *The Humanities in Precollegiate Education,* Par II. Chicago, Illinois: The Society, 1984.

# Balancing Chemical Equations by High School and College Students, and Pre-service Science Teachers

A.C. PACHAURY
**Reader in Education**
**Regional College of Education**
**Shyamla Hills, Bhopal 462 013**

---

*In Indian subjects, deficiency regarding concrete operational thought is also reported. The majority of our school-going pupils and college youths are at best only early formal thinkers (Pachaury, 1989).*

---

In the late 80s, lots of changes have been effected in the school science curriculum. A major shift in this regard has been in the content domains, but practically nothing has been done to incorporate *the processes of science*. Among the numerous modes of processing scientific information by the pupils, concrete and abstract dimensions of the content seem to influence thinking the most. According to Piagetian theory, formal operational thinking begins to emerge around the age of 11 or 12. Proportionality forms one of the basic schemes of the mental structure of a formal thinker Formal thinking banking on this scheme can be negated through its inverse operativity. It, then, as well, provides mental functioning at the formal level of thinking. Balancing of chemical questions also utilizes the inverse proportionality scheme. Depending on the nature of the chemical reaction, an individual would need one, two, three steps or so to balance a chemical equation. The major purpose of this study is to ascertain the developmental characteristics of this skill in the subjects of differing levels of chemistry instruction. Specifically, the following research question is posed for this investigation.

Do the high school pupils, the first and third year college students and the pre-service science teachers differ among themselves on balancing a chemical equation needing one, two, three, four and five step solution?

The following null hypotheses were tested in this study:

1. There is no difference among high school pupils, first and third year college students and pre-service science teachers on balancing a chemical equation needing one-step solution.
2. There is no difference among high school pupils, first and third year college students and pre-service science teachers on balancing a chemical equation needing two-step solution.
3. There is no difference among high school pupils, first and third year college students and pre-service science teachers on balancing a chemical equation needing three-step solution.

4. There is no difference among high school pupils, first and third year college students and pre-service science teachers on balancing a chemical equation needing four-step solution.
5. There is no difference among high school pupils, first and third year college students and pre-service science teachers on balancing a chemical equation needing five-step solution.

### Subjects

225 students participated in this study as shown in Table 1. This table also shows mean scores on different equations for high school pupils, first and third year college students and pre-service science teachers ($X_H$; $X_1$; $X_3$ and $X_B$ respectively).

### Data Collection

Data were collected through a cyclostyled sheet containing five unbalanced chemical equations. One intact class of I year and B.Ed. and two intact classes of X and III year were involved in data collection. Time taken to complete this task varied from 10 to 15 minutes.

### Scoring

Each equation balanced correctly was given a score of one and an unbalanced equation received a score of zero. Mean scores were then calculated for the four groups on each of the five equations. They are shown in Table 1.

### Treatment of Data

Data were treated statistically in two steps. ANOVA tests were run for testing the null hypotheses 1 to 5. '*t*' tests were computed for contrast pair mean differences on the unaccepted hypotheses. All the significant values were accepted at .05 level.

### Results

*Equation 1:*

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + H_2O$$

ANOVA yielded an $F$ value of 4.13, which is significant at .01 level. Hence, the null hypothe-

**TABLE 1**
**Mean Scores for Different Groups on Five Equations**

| *Grade* | *N* | *Equations* | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| X | 70 | 0.95 | 0.90 | 0.63 | 0.41 | — |
| I year | 39 | 0.94 | 0.94 | 0.92 | 0.82 | 0.15 |
| III year | 68 | 0.88 | 0.97 | 0.68 | 0.76 | 0.11 |
| B.Ed. | 48 | 0.77 | 0.91 | 0.48 | 0.66 | 0.25 |
| | 225 | | | | | |

**TABLE 2**
**$F$ Value and $t$ Values for Contrast Pairs on Equation 1**

$F = 4.131$ $df = 3, 221$ $p < .01$
HO not accepted

| *Contrast pair* | $t$ | $p$ |
|---|---|---|
| $X_1 - X_H$ | −0.17 | NS |
| $X_3 - X_H$ | −0.14 | NS |
| $X_3 - X_1$ | −1.00 | NS |
| $X_B - X_H$ | −3.27 | .01 |
| $X_B - X_1$ | −2 65 | .01 |
| $X_B - X_3$ | −2.20 | .05 |

sis of no mean difference among the four groups on balancing a chemical equation involving one-step solution is not accepted. '$t$' tests were run for the contrast pair differences. Following conclusions are drawn from Table 2:

No significant differences exist between the subject of I year and high school ($t = 0.17$; $df$ 107; $p > .05$); III year and high school ($t = 0.14$; $df$ 136; $p > .05$) and III year and I year ($t = 1.00$; $df$ 105; $p > .05$) on balancing a chemical equation involving one-step solution.

III year, I year and high school students' performance on balancing this chemical equation was significantly better than the pre-service science teachers' ($t = 2.20$; $df$ 114; $p < .05$; $t = 2.65$; $df$ 85; $p < .01$ and $t = 3.27$; $df$ 166; $p < .01$ respectively).

*Equation 2.*

$$HCl + Na_2CO_3 \rightarrow NaCl + H_2O + CO_2$$

For this equation, ANOVA yielded an $F$ value of 0.097, which is insignificant at .05 level. Hence,the null hypothesis of no mean difference among the four groups on balancing a chemical equation involving two-step solution is accepted.

**TABLE 3**
**$F$ Value and $t$ Values for Contrast Pairs on Equation 2**

$F = 0.997$ $df = 3, 221$ $p > .05$
HO accepted

*Equation 3.*

$$Fe(OH)_3 + H_2SO_4 \rightarrow Fe_2(SO_4)_3 + H_2O$$

**TABLE 4**
**$F$ Value and $t$ Values for Contrast Pairs on Equation 3**

$F = 6.92$ $df = 3, 221$ $p < .01$
HO not accepted

| *Contrast pair* | $t$ | $p$ |
|---|---|---|
| $X_1 - X_H$ | 3.22 | .01 |
| $X_3 - X_H$ | 0.065 | NS |
| $X_3 - X_1$ | −2.66 | 01 |
| $X_B - X_H$ | −1.87 | NS |
| $X_B - X_1$ | −4.58 | .01 |
| $X_B - X_3$ | −2.50 | .05 |

For this equation, ANOVA yielded an $F$ value of 6.92, which is significant at .01 level. It is obvious then that the performance of the four groups significantly differs on balancing a chemical equation involving three-step solution. Therefore, null hypothesis is not accepted. '$t$' tests were calculated for the contrast pair differences.

Following conclusions are drawn from observations of Table 4:

No significant differences exist between students of B.Ed. and high school ($t = 1.87$; $df$ 116; $p > .05$) and III year and high school ($t = 0.065$; $df$ 136; $p > .05$) on balancing a chemical equation involving three-step solution

III year and I year students' performance on balancing this chemical equation was significantly better than that of pre-service science teachers ($t = 2.50$; $df = 114$; $p < .05$ and $t = 4.58$; $df = 85$; $p < .01$). First year students' performance was also significantly better than that of III year and high school subjects ($t = 2.66$; $df = 105$; $p < .01$ and $t = 3.22$; $df = 107$; $p < .01$).

*Equation 4:*

$$H_3PO_4 + CaSO_3 \rightarrow Ca_3(PO_4)_2 + SO_2 + H_2O$$

**TABLE 5**

**$F$ Value and $t$ Values for Contrast Pairs on Equation 4**

$F = 9.56$ $df = 3, 221$ $p < .01$

HO not accepted

| *Contrast pair* | $t$ | $p$ |
|---|---|---|
| $\bar{X}_1 - \bar{X}_H$ | 4.60 | .01 |
| $\bar{X}_3 - \bar{X}_H$ | 4.66 | .01 |
| $\bar{X}_3 - \bar{X}_1$ | −0.67 | NS |
| $\bar{X}_B - \bar{X}_H$ | 3.00 | .01 |
| $\bar{X}_B - \bar{X}_1$ | −1 66 | NS |
| $\bar{X}_B - \bar{X}_3$ | −1.20 | NS |

For this equation, ANOVA yielded an $F$ value of 9.56, which is significant at .01 level. It is clear from this value that the performance of the four groups significantly differs on balancing a chemical equation involving four-step solution. Hence, null hypothesis is not accepted. '$t$' tests were calculated for the contrast pair differences. Following conclusions are drawn from Table 5:

No significant differences exist between students of B.Ed. and III year ($t = 1.20$; $df$ 114; $p > .05$); B.Ed. and I year ($t = 1.66$; $df$ 85; $p > .05$) and III year and I year ($t = 0.67$; $df$ 105; $p > .05$) on balancing a chemical equation involving four-step solution. Pre-service science teachers' performance was significantly better than that of high school subjects ($t = 3.00$; $df$ 116; $p <$ 01). Third year students' performance was also significantly better than that of high school subjects ($t = 4.60$; $df$ 136; $p < .01$). First year subjects as well performed significantly better on this equation than high school subjects ($t = 4.60$; $df$ 107; $p < .01$).

*Equation 5:*

$$2H_2XO_3 + H_2ZO_3 \rightarrow HX + H_3ZO + H_2O$$

**TABLE 6**

**$F$ Value and $t$ Values for Contrast Pairs on Equation 5**

$F = 6.69$ $df = 2, 152$ $p < .01$

HO not accepted

| *Contrast pair* | $t$ | $p$ |
|---|---|---|
| $\bar{X}_3 - \bar{X}_1$ | −0.54 | NS |
| $\bar{X}_B - \bar{X}_1$ | 1.26 | NS |
| $\bar{X}_B - \bar{X}_3$ | 2.05 | .05 |

For this equation, AVONA yielded an $F$ value of 6.69, which is significant at .01 level. It is obvious then that the performance of the three groups i.e., B.Ed., III year and I year students significantly differs on balancing a chemical equation involving five-step solution. Hence, null hypothesis is not accepted. '$t$' tests were run for the contrast pair differences. Following conclusions are drawn from Table 6:

No significant differences exist between students of B.Ed., and I year ($t = 1.26$; $df$ 85; $p > .05$) and III year and I year ($t = 0.54$; $df$ 105; $p > .05$) on balancing a chemical equation involving five-step solution. Pre-service science teachers performed significantly better than the III year students on this equation ($t = 2.05$; $df$ 114; $p < .05$).

## Discussion

Niaz and Lawson (1985) argue that these five equations form a hierarchical cluster. The first equation requires the one-step solution, while the equation V would need the five-step solution. Negotiation of equations I and II by the subjects of this study has been quite satisfactory as evidenced by the mean scores ranging from 0.77 to 0.97. For the X grade subjects, equations III and IV have proved to be difficult, since almost 50% of these pupils missed them. As for the I year and III year subjects, their performance on these equations ranged from 68% to 92%. The pre-service teachers' performance on these equations is very much like that of the high school pupils (48% and 66%). No pupil of the X grade could balance the chemical equation involving five steps. Other subjects as well performed on this task (15% I year; 11% III year and 25% B.Ed.) poorly. As many as 50% of the secondary school and college-age subjects too have failed to demonstrate the use of this inverse proportionality scheme in their thought processes (Karplus and Peterson, 1970; Lawson and Renner, 1974; Lovell et al., 1961; Lunzer, 1965; Wollman and Karplus, 1974)—cited by Wollman and Lawson (1978). Poor performance on the beam balance task (20%) by the college seniors is also reported by Good (1977). The findings of this study that the subjects lack mental structure to negotiate the five-step solution of chemical equation are supported by the studies referred to above. It is inferred on the basis of these studies that even the primary scheme of proportionality requiring functioning at the formal operational level is asymptotically distributed here and abroad. Misconceptions of the abstract science concepts then should result due to the non-availability of mental structures to accommodate the executive inverse proportionality scheme with these subjects. In Indian subjects, deficiency regarding concrete operational thought is also reported. The majority of our school-going pupils and college youths are at best only early formal thinkers (Pachaury, 1989). At this juncture, I would like to raise a question: what do we expect of high school pupils by balancing four or five-step chemical equations? It certainly may be a necessary pre-requisite skill for all those who shall be pursuing chemistry vocation. But for all those who shall be landing in language arts and such other fields, schooling beyond ten-years seems to be much of an expectation. Balancing difficult chemical equations, therefore, be introduced at the +2 level. However, efforts should be made to design learning experiences that would need utilization of the scheme of inverse proportionality so as to gear up the formal thinking abilities of high school pupils.

## References

1. Good, R.G. *How Children Learn Science.* New York: Macmillan Publishing Co., Inc., 1977, pp. 119-120.

2. Niaz, M. and Lawson, A.E. "Balancing Chemical Equations". *Journal of Research in Science Teaching*, 1985, **22**, 1, pp 41-51.
3. Pachaury, A.C. "Cognitive Developmental Perspective and Learning of Science by the Disadvantaged Child". In *Teacher Education for Disadvantaged Children*, J.S. Grewal et al. (eds.), RCE, Bhopal-13, 1989, pp. 137
4. Wollman, W.T. and Lawson, A E "The Influence of Instruction on Proportional Reasoning in Seventh Graders". *Journal of Research in Science Teaching*, 1978, **15**, 3, pp. 227-232.

# Scanning Genes for Heart Disease

JOHN NEWELL
**Science and Industry Editor**
**BBC External Services**

*There are many well-known factors such as smoking, excessive weight and raised blood pressure that point to risk of coronary heart disease One that is less well-known, but which is the subject of intensive research in many countries is genetic predisposition If doctors could be armed with a suitable battery of genetic 'probes' it would be possible to screen people by taking blood samples and, by adding the genetic information from them to other data readily available from ordinary medical checks, pick out those persons who ought to be warned that a change in lifestyle was probably a matter of life or death before the age of forty.*

Coronary heart disease, CHD, in which the heart muscle becomes damaged by interruption of its normal supply of blood through the coronary arteries, is the leading cause of death in Britain and other western countries. CHD is only one-tenth as common in Japan and is rare in many developing countries. Deaths from CHD are now declining in the USA and Australia but the figures are static in Britain and most of western Europe; they are increasing in eastern Europe

The precipitating event of a heart attack is often thrombosis, the forming of blood clots in coronary arteries, superimposed on atherosclerosis, the narrowing of arteries because of their walls hardening and thickening.

Certain factors which predispose people to CHD are well known. They include smoking, obesity, high consumption of animal fats in meat or dairy products and high blood pressure There is also some evidence that people with a so-called type A personality, who are aggressive, competitive, insecure and always in a hurry, are at higher risk than those with the more relaxed type B personality, though studies have produced conflicting evidence. But it is clear that family background matters, too Whether or not close relatives, especially males, have suffered CHD is very important in assessing susceptibility. From this it is obvious that genetic as well as environmental factors are involved.

Inherited factors predisposing to CHD should perhaps be described as genetic variations rather than abnormalities, for some of them have effects on mortality only after childbirth and some of the genes may in fact have been advantageous to mankind in prehistoric times.

## Growing Understanding

In recent years techniques have been developed that make it possible to identify, isolate, multiply and analyse individual genes and their products. This has led to a growing understanding of how genes control the detailed biochemistry involved in atherosclerosis and inappropriate blood clotting. The way in which fats are transported in the blood stream and out of it through the walls of arteries is also becoming better understood. It is now known that a number of different genes are involved in controlling the

| Major or classical risk factors | Other risk factors |
|---|---|
| Increasing age | Hypertriglyceridaemia |
| Elevated plasma cholesterol due to high LDL levels | Increased response to glucose |
| Low HDL-cholesterol levels | Increased fibrinogen levels and ESR |
| Hypertension | Increased Factors VII and VIII |
| Cigarette smoking | Obesity |
| Diabetes | Stress |
| High saturated fat and cholesterol intake | |
| Type A personality | |
| Residence in soft-water areas | |

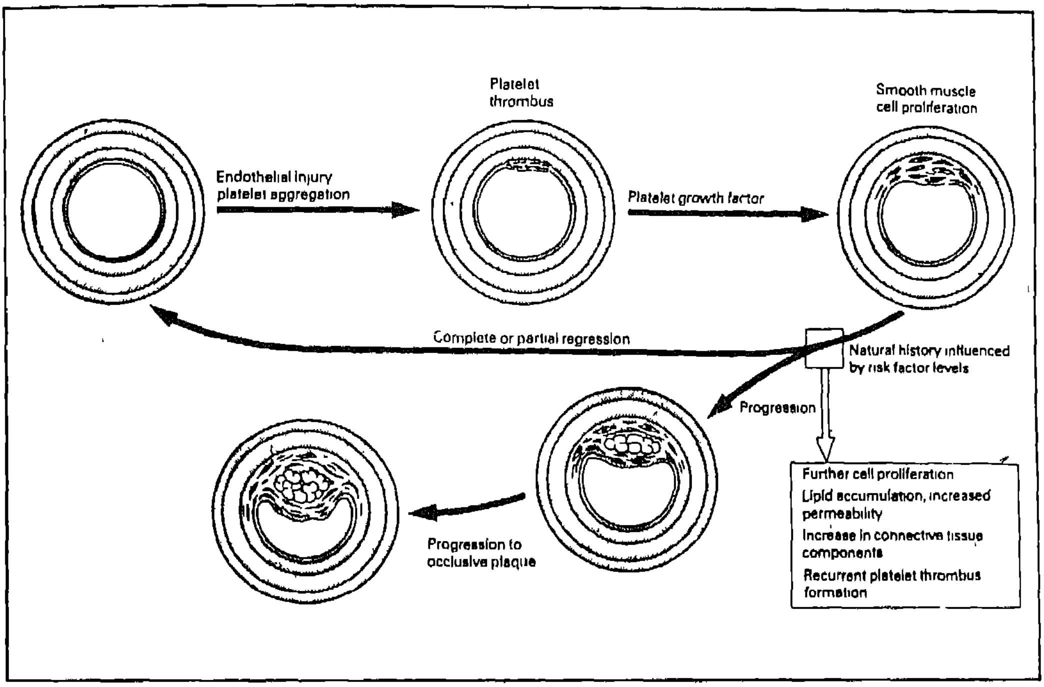
**Risk factors for coronary heart disease.** *A risk factor is an attribute which is predictive of an increased incidence of a disease. It is not necessarily a cause, for it may be merely associated with one. Several risk factors for CHD have been defined, using as end-points CHD death, major non-fatal events involving reduction of blood supply, or progression of atherosclerosis as determined by angiography.*

processes and that variations in these genes can strongly affect susceptibility to CHD.

The techniques for identifying and analysing genes responsible for particular aspects of human biochemistry are now routine and widespread in application. It is likely that within a few years all the most important genetic variations that can affect susceptibility to CHD will have been identified. Genetic probes will have been constructed to reveal the presence or absence of any such variations in DNA taken from a blood sample; some probes have already been developed. Each probe will chemically attach itself only within samples containing equivalent DNA carrying the identical variation in the gene under examination.

Intensive research on some of these genes and the variations in them which predispose to CHD is now going on in the new Sunley research laboratory attached to the Charing Cross Hospital at Fulham, in West London. Funded by the South London philanthropist Bernard Sunley, along with another laboratory at King's College Hospital in South London, the laboratory was completed in 1983. It now houses two research teams, one studying rheumatoid arthritis, the other of about 20 scientists led by Dr. Steven Humphries, an acknowledged world authority on the genetics of heart disease.

Dr. Humphries' team, funded by the British Heart Foundation, is studying genes which code for proteins that control the transport of lipids in the blood such as cholesterol; the receptors in arterial walls through which the proteins carrying lipids move out of the blood to be broken down and excreted; the activities of macrophages, scavenger cells which take up the lipids leaving the circulation, and the enzymes that break down lipids. The team is also studying the genes for fibrinogen, the blood protein that is snipped into smaller lengths when the blood clots and pro-


Platelet thrombus
Smooth muscle cell proliferation
Endothelial injury platelet aggregation
Platelet growth factor
Complete or partial regression
Natural history influenced by risk factor levels
Progression
Further cell proliferation
Lipid accumulation, increased permeability
Increase in connective tissue components
Recurrent platelet thrombus formation
Progression to occlusive plaque

**Hypothetical sequence of events in early atherogenesis.** *Atherosclerosis is a complex lesion containing several components in varying proportion, namely accumulation of cholesterol esters (at first in macrophages, later as extracellular deposits), overgrowth of smooth muscle cells (a single clone in each plaque), accumulation of collagen, glycosaminoglycans, fibrin and calcium. Early lesions are believed to be largely reversible unless certain risk factors are involved, in which case they are more likely to evolve into atheromatous plaques.*

duces fibrin, the main protein constituent of clots, or thrombi as they are known.

The several genes involved in susceptibility to CHD differ widely in their functions. One important gene is Apolipoprotein AI, Apo AI for short. It is the skeleton for the major component of the High Density Lipoprotein, HDL. This lipoprotein is involved in what is known as 'reverse cholesterol transport, whereby excess cholesterol is taken up from the artery walls and other cells by the HDL and carried to the liver, where it can be broken down to be excreted. High levels of HDLs have been firmly proved to be associated with a reduced risk of CHD.

## Genetic Variation

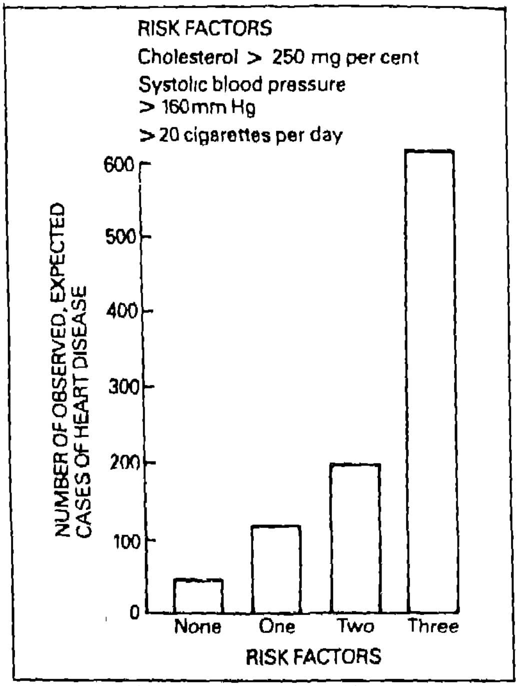
DNA technology makes it possible to identify variation at genetic level. The gene for Apo AI has been cloned and many 'DNA polymorphisms' have been detected with the probe. Scientists at the Sunley Research Centre have studied the frequency of these DNA polymorphisms in 174 men under 60 years of age who have had a myocardial infarction, which is a blockage of the blood supply to part of the heart muscle, or who have angina, and have compared it with results from healthy men. One of these polymorphisms is significantly more frequent in the patients when compared with the healthy men, confirming observations reported earlier from the USA. This marker is not in itself a useful diagnostic test for CHD risk, but it points the way for future research.

Unlike HDLs, Low Density Lipoproteins, LDLs, have been shown by epidemiological and other studies to be harmful when found in abnormally high levels in the bloodstream. They are thought to contribute to the build-up of the atheromatous plaque that thickens the arterial walls. Another gene, that for Apo B, codes for the protein component of LDL that binds to the receptors for LDL in arterial walls. Variations in this gene, and consequently in the affinity of the protein for the receptor, make it harder or impossible for LDL to be removed from the bloodstream via the receptors and so tend to raise the levels of LDL in the blood.

Other genes are known to affect the levels and functioning of lipoproteins in the bloodstream. The lipoprotein lipase gene, responsible for the enzyme which normally metabolises the triglyceride-rich lipoprotein, raises lipid levels if the gene and consequently the enzyme for it have an abnormal structure. If this is so the enzyme cannot interact with lipids as effectively as it does normally.

High concentrations of serum lipids predispose to CHD because they tend to accumulate in the arterial wall, causing thickening and narrowing. The blood clotting mechanism, which normally functions as the first stage in wound healing, can also predispose to CHD if the blood tends to clot too readily. If this is so, clots may be formed without wounding having occurred and may block constricted arteries, adding to the narrowing effect.

The first step in wound healing and thrombi formation is the breakdown of fibrogen into fibrin. Dr. Humphries and his colleagues have identified genetic variations which are associated with abnormally high levels of fibrogen in the bloodstream. They in turn may be associated with increased susceptibility to CHD.



**The synergistic effect of smoking, hypertension and raised cholesterol.** *Many of these risk factors are strongly additive; for example, the co-existence of mild hypercholesterolaemia, mild hypertension and cigarette smoking increase CHD risk about eightfold in middle-aged men. The effect of the classical risk factors is more conspicuous in younger subjects Beyond the age of 50 to 60, smoking and total plasma cholesterol levels lose their predictive power, but LDL and HDL plasma lipoproteins, which together carry 80 to 90 per cent of circulating cholesterol, remain predictive of risk up to an advanced age.*

## Feedback Mechanisms

Dr. Humphries' team is also probing the feedback mechanisms that normally control fibrinogen levels in the blood. White blood cells can take up fibrinogen fragments in the blood that are formed in the process of producing fibrin for blood clotting. This then stimulates the cells to produce a substance called hepatocyte stimulating factor. As its name implies, it stimulates the liver to make more fibrinogen to supply the deficiency left by the manufacture of fibrin.

People with abnormally high levels of fibrinogen, and therefore at high risk of CHD, may have such high levels because of over-stimulation of hepatocytes, due in turn to too much stimulating factor. Dr. Humphries is examining the hypothesis that this excess is produced by foam cells 'over-stuffed' with cholesterol. Workers in his group have shown that a medium in which foam cells have been cultured does indeed stimulate hepatocytes to produce more fibrinogen.

Other genes are known to control the behaviour of the macrophages, scavenging cells found in the arterial walls which absorb cholesterol from the blood to high concentrations and which in the process become what have been nicknamed 'foam cells' because of their appearance when stuffed with cholesterol. Among the specific studies in progress at the Sunley Research Centre is a project in which monocytes, the precursors of macrophages, are being cultured to develop into macrophages and are then having cholesterol added to them, allowing their behaviour to be studied under controlled conditions.

RNA, the genetic material ribonucleic acid, is extracted from these macrophages in a search for RNA that codes for Apo E, a protein involved in removing cholesterol from macrophages. A deficiency in RNA for Apo E, caused by a defect in the Apo E gene, may lead to a consequent deficiency in the Apo E protein itself. The hypothesis being explored is that this can lead to macrophages becoming so overloaded with cholesterol that they contribute to the formation of the plaque that thickens arteries in atherosclerosis

## Battery of Probes

The ultimate ambition of Dr Humphries' team is to take its studies to the point where they can be put to work in preparing gene probes to identify the genetic variations that may increase a person's susceptibility to CHD With a battery of such probes, it would then be possible to perform 'gene scans' on DNA from blood samples, taken either from patients (including out-patients seen with arterial disease at the Charing Cross Hospital) or from people who walk into the clinic off the street. Such people might be worried because of a family history of CHD or because of early warning symptoms, or perhaps because of their way of life. The great advantage would be that genetically susceptible people might be detected early, even before symptoms of arterial disease appear.

It would then be possible to add together data about personality type, nature of work and so on, blood pressure, weight, smoking habits, biochemical data from the blood sample and precise genetic information. That should make estimates of a person's liability to CHD much more accurate. It would enable doctors to advise on lifestyle as well as to prescribe treatment with much more authority. While one patient with no genetic predisposition to CHD might be mildly warned to lose weight, smoke less and avoid a diet rich in animal fats, another, with several genetic factors clearly pointing to risk, might be warned that a change in lifestyle was probably a matter of life or death before the age of forty.

The Charing Cross Hospital sees over 1000 patients every year with arterial disease, often at an early stage. Figures are similar for other large general hospitals. As the several teams working on the genetics of heart disease in various countries (all co-operating closely with one another) close in on their genetic targets, we can hope to see increasingly precise estimates of risks and consequently more precise and authoritative prescriptions and advice. This should do a great deal to reduce the toll from CHD, the western world's leading killer.

Courtesy: *Spectrum*

# Models Approach to the Teaching of Biology

BHARATI BAVEJA
**Reader**
**Department of Education**
**Delhi University, Delhi**

*Several teaching models have been developed to realize different teaching goals since no single method can achieve all the purposes. If teachers learn a set of teaching models which by and large cover the entire range of objectives specified for biology teaching they would be in a position to pick and choose a model most appropriate to the learning situation. Since learning is an outcome of interaction between learner, teacher and the surrounding environment, learning situations are bound to be unique and emergent. To be able to cope effectively with the emergent demand of the classroom, models mastered would serve as suitable action plans and make every moment in the instructional process 'productive'.*

The demand put forth by society on biology is tremendous, vital and varied, ranging from the increase of food production and maintenance of ecological balance to the conquering of fatal diseases. Arising out of these needs are a variety of educational objectives in terms of knowledge, attitudes and skills, formulated for biology teaching at various levels. The present state of biology learning leaves much to be desired. As in other areas of knowledge, biology learning is also confined to acquisition of facts. Any educational system which is geared to impart factual information is bound to encourage rote memorization. Teaching of isolated facts without due emphasis on their functional aspect renders biology uninteresting and meaningless to a school child. The tradition of practicals following theory curbs the basic quest of child to inquire. The whole plight of biology education can be appraised when a child gives an accurate verbal description of a concept but fails to comprehend it when encountered in reality. Such instances compel us to think whether learning is actually taking place and what is the purpose of education?

Eminent psychologist Jerome Bruner has rightly pointed out the purpose of education by asking "whether the education should consist of learning of specific subject matter or acquiring of process skills which will help in learning of a particular subject matter." According to Bruner the ideal process learner is the one learning to put things together in order to generate concepts Learner practises the kind of thinking required to create concepts by combining information. In his "Process of Education" Bruner has concluded that teaching should be concerned with teaching of subject matter which will provide a blueprint or a coding system that people can use to generate new information. "Helping children learn concepts is the fundamental purpose of schooling." (Bruce and Weil, 1972).

There is rich information available on nature of concepts, concept learning, conditions influencing the process of conceptualization, etc., from the work of various eminent researchers on concept learning. Based upon these theories a number of instructional strategies or teaching models have been developed. Similarly, based upon other views about learning proposed by various other distinguished psychologists, therapists, educators, sociologists, system analysts a variety of 'teaching models' achieving different purposes have been designed. Every model has been developed rationally on the basis of some sound theory as to how children learn with a view to achieve certain objectives Thus every model has goals, theoretical assumptions and underlying principles Though models approach to teaching is comparatively a new concept, yet the components of models are usual teaching acts widely practised in classrooms from decades. Novelty of this approach lies in the specific combination of teaching acts, learning environments and objectives to be accomplished The type and sequence of learning activities, during a lesson is distinct to every model. Each model gives clear directives as to how to regard the learner and how to respond to his behaviour. There is a specific type of social structure encouraged by every model which defines roles of students and teachers, and their relationships.

Several teaching models have been developed to realize different teaching goals since no single method can achieve all the purposes If teachers learn a set of teaching models which by and large cover the entire range of objectives specified for biology teaching they would be in a position to pick and choose a model most appropriate to the learning situation. Since learning is an outcome of interaction between learner, teacher and the surrounding environment, learning situations are bound to be unique and emergent. To be able to cope effectively with the emergent demand of the classroom, models mastered would serve as suitable action plans and make every moment in the instructional process 'productive'. 'Repertoire orientation' to teaching and 'flexibility' are the key concepts underlying the models approach to teaching.

Factors which basically determine the choice of teaching models are nature and structure of the subject matter and the aims to be realised Further screening can be done on the basis of capabilities of the learners, specific objectives to be achieved, related outcomes to be nurtured and resources available. Where and when the need arises, model selected may be modified or even dropped and another one picked up. They can even be used in parts during a lesson; it all depends upon the needs of the learning situation. "A highly skilled performance in teaching blends the variety of models appropriately and embellishes them" (Joyce and Weil, 1972)

Nature of biology emphasises both, body of knowledge and the process of acquiring knowledge. Concept learning, problem solving and theory building skills are essential to the effective learning of the discipline. Biology has a very well defined conceptual organisation with concepts hierarchically organised like biosphere, biome, ecosystem, molecules. The subject discipline may be seen as levels of hierarchically organised concepts that begin with perceptual data at the bottom (instances that can be directly sensed) and proceed through increasing levels of abstractions, to the most abstract concept at the top. Thus, while teaching, one can proceed in two ways—top to bottom or bottom to top, i.e., beginning with a more general, encompassing abstract statement of a concept and proceeding towards its specifics or starting with specific examples of a concept, drawing out similarities among them and building a general concept; whereas latter is an inductive approach, the former is deductive. Both kinds of reasoning are essential for theory building. Which path one follows is really not a matter of choice. The teacher has to gauge which way children will learn better by asking himself—has the child's thought process developed enough to construct reality from abstract statements or he needs concrete experiences to understand a concept? The teaching approach has essentially to be matched with students' thought processes

At primary and secondary level inductive approaches have been found to be more effective whereas deductive approaches are considered to be suitable for senior secondary classes. Nevertheless, this should not be taken as a 'rule of thumb'. Whenever abstract concepts in the new areas are to be dealt with, inductive approach should be preferred. With this background many models designed for 'Information Processing' can be used to teach biology. Model designed to teach concepts deductively is the 'Advance Organizer Model' (AOM). The ones which teach concepts inductively are 'Concept Attainment Model' (CAM) and 'Inductive Thinking Model' (ITM). All these models emphasise the process of acquiring knowledge also. One of the models specially designed to teach the process of scientific inquiry is the 'Inquiry Training Model' (ITrM).

The AOM advocates deductive teaching of concepts and is based upon Ausubel's ideas about 'subject matter', 'cognitive structure' and 'advance organizers'. It aims at strengthening active reception learning where students receive readymade knowledge from the teacher It begins with a broad, general, abstract statement and proceeds to its subordinate and superordinate concepts in a coherent way. It therefore resembles traditional way of teaching. Nevertheless, its special features like 'advance organizer', 'progressive differentiation' and 'integrative reconciliation' make it a model which can be used to deliver effective lectures. Keeping in view the limited scope of this article AOM which relates to traditional mode of teaching will not be discussed in details. References Nos. 1, 2, 3, 4, 9, given in bibliography provide a detailed account of this strategy.

'Concept Attainment Model' has been developed from the work of Jerome Bruner and his associates on 'study of thinking' which concluded in 1956. Bruner asserts that categorization is the basis of all cognitive (mental) activities. All categorizing activities involve identifying and placing of instances into groups on the basis of certain characteristics ignoring the others. Different processes of categorization can be recognised and superior ones identified. One could then suggest conditions conducive to development and nurturing of superior thinking strategies. CAM thus aims at providing effective thinking strategies leading to efficient problem solving.

CAM is basically different from AOM in that it proceeds from specific examples of a concept to its abstract construct (inductively) Secondly, concepts are not taught directly (no reception learning), instead students learn concepts by seeing examples. They actively engage themselves in the process of discovery. The teacher facilitates this process by providing series of examples. To begin with, the teacher decides upon the concept to be taught for a given lesson and collects an array of instances. In this array there are instances which exemplify the concept (examples) as well as instances which do not exemplify that concept, the non-examples. Non-examples should resemble examples in some respect but must differ with regard to some important features. Examples and non-examples are presented alternatingly till students are able to identify the elements of the concept. Students then define the concept and give additional examples. This series of tasks leads to concept attainment. Thereafter students' thinking strategies are analysed to identify the effective ones.

Suppose a teacher wants to teach the concept of 'compound leaf' using CAM, then he/she has a concept in mind which students have to find out. To help them solve this problem the teacher presents specimens of compound and simple leaves one after the other. After an instance is presented the teacher signifies whether it represents or not the concept in mind. One can also make use of diagrams, pictures, models, written material etc. as examples and non-examples of the concept. Students are asked to observe every instance carefully and focus on features which are common to all the examples and, at the same time, are not represented in the non-examples of the concept. By the process of comparison and differentiation students are expected to identify main features of the concept and define it. For the example being considered teacher would first show a specimen of leaf in which all the essential characteristics of a compound leaf are clearly visible. She/he would then provide a specimen of simple leaf, then again a compound leaf followed by simple leaf. This activity continues till most of the students raise their hands to indicate that they have been able to figure out the concept or the distinguishing features of the concept. Students are asked to list the essential attributes of the concept or define the concept. They may or may not be able to name the concept. In the later case, the teacher names the concept.

For the case in point, students may say, the concept that the teacher has thought of, has incised leaf blade, where leaf margin touches the midrib or the petiole forming leaf segments or leaflets and there is an axillary bud at the base of the petiole. Teacher would then say that such leaves are called compound leaves. In order to ensure that students have actually conceptualized the idea and are not merely repeating words without understanding, the teacher asks them to recognise additional examples. Thus they should be able to distinguish compound leaves from simple leaves and compound leaves from branches in a given sample of specimens. Finally they are asked to give examples of their own from their daily life experiences. Students' thinking strategies are then analysed.

Evidently, in CAM students are not passive recipients of knowledge. They get opportunity to observe, speculate, test their hunches, draw conclusions, make generalizations and ultimately to predict. This is the gist of inquiry. CAM provides to students the opportunity to think and to improve upon their thinking processes, enabling them to become better problem solvers, a highly cherished goal of education. CAM is primarily meant for developing inductive reasoning but it also provides for concept development and acquainting students with the process of conceptualization. This helps them improve their concept building strategies. Hence it suggests guidelines for curriculum and instruction designing.

CAM can be used for all age levels and for all types of concepts. In biology concepts that are concrete have numerous examples in the surroundings (or specimen easily available) can be very effectively taught using this model. Specifically speaking, concepts from morphology, anatomy, histology, taxonomy, etc., lend themselves suitably to this model.

There are three variations of this model which differ in terms of degree of freedom given to the students. The model described above is 'reception oriented' and is highly structured as compared to the other two variations. Interested readers may refer to Bruner's book on *Study of Thinking*.

'Inductive Thinking Model' which also teaches concepts inductively is basically designed to develop inductive mental processes and theory building ability. ITM has been developed from the work done on curriculum by late Hilda Taba. She designed a series of teaching strategies for development of inductive mental processes, especially the ability to categorise and use categories. She believed that these mental processes would improve students ability to handle information. The three teaching strategies designed by her are 'concept formation', 'interpretation of data' and 'application of principles'. These strategies strictly follow the above-mentioned sequence in any inductive thinking lesson.

In the first phase of the lesson, i e., concept formation, students identify and enumerate data relevant to the problem, put this data into categories and give names to these categories. Let classification of plants serve an example to illustrate functioning of this model. According to this model, students' task would be to identify and put different types of plants around them into various categories. To induce this activity students are exposed to various types of plants representing the major groups of plant kingdom. This can be done through, excursion, film showing different types of plants, pictures or display of actual specimens in the classroom. The first task is to make a list of plants observed. This can be done either by the teacher or by the students depending upon the requirement of the situation. Students are then asked to put the observed specimens (data) into as many categories as they want. They are allowed to put one specimen (datum) into more than one group and are also free to form simple as well as complex categories (with sub-divisions). They also have the freedom of selecting any criterion or basis of classification unless specified. The only requisition is that students justify whatever they do. They give reasons for decisions taken. Students can work singly or in groups. Group work should be preferred since it promotes development of desirable cognitive and effective behaviours apart from being convenient in large classrooms. When the students have observed all the specimens, enumerated and categorised them, the teacher discusses their categories as to what they have grouped together and why. The teacher also asks them to point at different structures in the specimens in order to ensure accurate understanding. Students are frequently reinforced positively to encourage inductive thinking. Later, they are asked to give names to their categories which may not necessarily be stated in officially accepted terms; in fact most of the time students give their own names. This should be encouraged; at the same time formal technical terms provided. For the example on hand, students may form classes on the basis of colour, size, shape, utility, etc., and give names like tallies, dwarfies, green plants, etc. Scope of classification could be narrowed down by asking for structural or morphological basis of classification.

In the next phase, i.e., 'interpretation of data', students are asked to write a sentence or a statement describing as many categories as possible. This enables students to go beyond the given data; they learn to generalize. It is heartening to note that students come out with brilliant explanations. To quote an example from the research data of the writer on TTM, one group of students formed following statement (generalization): "In some plants seeds are naked while in other they are enclosed. Some plants bear flowers, some do not. Yet every plant has a device to reproduce for survival of its species" (Sample age-group 14+).

During the third phase, 'application of principles' students predict consequences, explain unfamiliar phenomenon, verify predications. To initiate these behaviours questions like, 'what would happen if a mesophytic plant is kept in zerophytic conditions?', 'why do you think this plant would not survive?', 'what modifications would enable it to flourish under zerophytic conditions?', etc., are asked. Based upon the above mentioned three strategies students experience series of task leading to the development of inductive thinking. Potentialities of this model are self evident. ITM is specially relevant to the teaching of biology owing to the nature of content. Taxonomy, morphology, comparative anatomy, comparative physiology and similar other topics in botany and zoology can be effectively approached with this model. ITM can be used for variety of purposes other than mentioned earlier. It serves as an excellent device for opening and closing a unit, identifying weak areas of students and spotting specific misconceptions. Young children are expected to benefit substantially from this model. Students of higher classes who have to learn large quantities of information would find ITM very useful since concept formation is a means of bringing discrete items together into large conceptual schemes.

Teaching of biology, for that matter science, would always remain incomplete unless students are taught the process of inquiry. Training in scientific method, i.e., systematic way of investigation, necessitates that students experience creation of knowledge in a systematic way. Scientific literacy in true sense would entail correct understanding of nature of science. Students' exposure to learning experiences which take them through miniature versions of inquiry processes are beautifully designed in Inquiry Training Model. This model has been developed by Richard Suchman by combining main elements of creative inquiring procedures. These elements are observations, collection and organisation of data, identification of controlling variables, formulation and testing of hypotheses, explaining and drawing of inferences. ITrM leads students through above-mentioned processes systematically and co-operatively. Suchman believes that cooperative inquiry enriches thinking. It also enable students to appreciate the tentative, emergent nature of knowledge and the plausibility of alternative explanations. The ultimate goal of this model is to produce individuals who raise questions and find their answers.

This model begins by presenting a puzzling event or a discrepancy to students which motivates them to inquire. Students ask series of questions related to the problem in order to verify facts of the situation. They seek information regarding the nature and identity of the objects, events and conditions surrounding the puzzling event. This enables them to isolate variables relevant to the problem. They then try to see relationship between independent and dependent variables and conduct verbal or actual experiments to establish cause and effect relationship. With enriched understanding, students draw inferences which explain the discrepancy. Though the main purpose of this model is to teach inquiry procedures, students also gain information.

ITrM requires the content to be moulded into a problem. Any phenomenon which is unusual, unknown, shows unexpected outcomes serves as a good source of discrepancy. To mention a few instances from mutations, crossing over, linkage, hybridization, pollution, ecological imbalance, nutrition, etc., would serve as good intellectual confrontations around which ITrM can be built. Another crucial characteristic of this model is the form of questions which students can ask. Every question put by students would be so formulated that it can be answered as a yes or a no. No other forms of questions are answered by the teacher. This rule of inquiry puts the responsibility of conceptualizing and explaining on the students and makes them focus their problems specifically.

For instance, the teacher who wants to discuss about vitamin B presents the problem statement as, "A rich poulterer had 100 chickens in his farm. He had 6 people to help him look after the farm. Chickens were fed on a variety of diet. One day while inspecting the farm the poulterer realised that some of his chickens showed improper neuro-muscular coordination. He understood that these chickens had developed a neuro-muscular disease but was unable to think of its cause. Can you suggest a plausible reason?"

After addressing the problem to the students, the teacher explains the procedure of inquiry regarding the type of questions to be asked. To collect data relevant to the problem, students may ask, "Did the affected chickens have any viral infection?", or "was the place adequately ventilated?" Thus, they explore various possibilities and identify independent variables; they then hypothesise by establishing relationships between independent and dependent variables. Students may ask, "was the disease due to a dietary factor?", "did they eat polished rice?" Gradually narrowing down the scope of investigation by eliminating variables that do not affect the dependent variable, students arrive at an explanation which the teacher verifies.

At the end of the lesson, students are asked to reflect back on their processes of inquiry, the thinking en route to solution. This makes them conscious of their mode of inquiry and helps them identify elements of efficient inquiry.

ITrM can be used at all age levels with suitable adaptations. Problems can be presented verbally, through demonstrations or experiments. Any content that lends itself to a puzzling event can be taught using this model.

Based upon 'Models Approach' an effective programme in biology can be developed. One could begin a unit with AOM or ITM and teach the individual concepts using CAM, again go back to ITM or AOM if required. One could even proceed the other way round wherever possible, seizing the opportunity to impart training in inquiry. There is justification in being satisfied with the traditional way of teaching, which is simply a rhetoric of conclusions. Series of positive statements are given without any qualifications. Such an exposition fails to convey true nature of science and does not fit into the framework of good teaching.

## Bibliography

1. Ausubel, D. *The Psychology of Meaningful Verbal Learning.* New York: Grune and Stratton, Inc., 1963.
2. Ausubel, D. *Educational Psychology: A Cognitive View.* New York: Holt, Rinehart and Winston, 1968.
3. Ausubel, D. "The Use of Advance Organizer in the Learning and Retention of Meaningful Verbal Material". *Journal of Educational Psychology*, 51 (1960), 267-72.
4. Barron, R.R. "The Effects of Advance Organizers upon the Reception, Learning and Retention of General Science Concepts". DHEW Project No. 1B-030, ERIC Document Reproduction Service, ED 061554, Nov. 1971.
5. Bruner, J.S., Goodnow, J.J. and Austin, G.A. *A Study of Thinking.* New York: John Wiley, 1956.
6. Bruner, J.S., Otver, R.R., Greenfield, P.M. et al. *Studies in Cognitive Growth.* New York: John Wiley and Sons, Inc., 1966.
7. Bruner, J.S. *The Process of Education.* Cambridge: Harvard Press, 1960.
8. Eggen, P., Kauchak, D.P. and Harder, R.J. *Strategies for Teachers.* Englewood Cliffs, N.J.:Prentice-Hall, Inc., 1979.
9. Joyce, B. and Weil, M. *Models of Teaching.* Englewood Cliffs, N.J.:Prentice Hall, Inc., 1980.
10. Joyce, B., Brown, C. and Peck, L. *Flexibility in Teaching.* Longman, Inc., 1981.
11. Taba, H. "Teaching Strategies and Cognitive Functioning in Elementary School Children". Cooperative Research Project 2404. San Francisco: San Francisco State College, 1966.
12. Taba, H. *Teacher's Handbook for Elementary Social Studies.* Reading, Mass.: Addison-Wesley Publishing Co., Inc., 1967.

# Women in Science and Technology

SURJA KUMARI
**Department of Education in Science and Mathematics**
**NCERT, New Delhi 110 016**

*The creativity of women is eroded from the very first years by the passiveness that girls are encouraged to adopt, the discrimination between boys and girls, the socially determined and assigned roles that are offered to them and the absence of viable feminine models.*

The basis of all social relations and institutions in any society is its means and the mode of production. Starting with the seventeenth century, science and technology have increasingly played a decisive role in shaping these means of production. Women constituting half the population have been naturally affected by this scientific-technological revolution in various ways.

First, consider the numerical involvement of women in science and technology. The school board results have the salient feature that in science subjects also the girl students not only have higher percentages, but also figure relatively more amongst the high achievers. In spite of this, the number of women in science and technology is small due to sociological factors. Woman's education in general and scientific education in particular is far behind man's education. There is systematic exclusion of women from the higher ranks of science and concentration in subordinate positions. There is a rule—the more the money, power and responsibility, the fewer women. There is discrimination in recruitment and promotion. To achieve same grades, women have to be 'better' and with higher qualification. Of course the reason is that the selection committees are male or male dominated and the managing committees are almost exclusively male. The national bodies directing and controlling science and technology are almost all controlled by men, relegating the women to the executive functions.

The most powerful reason for this state of affairs is that the classical feminine stereotype still remains intensely powerful. Woman scientists are more rare at scientific meetings than in the laboratory. There is a persistent attribution to women of more soft feminine characteristics, no ambition and no creativity which make them incapable of high scientific achievement. The creativity of women is eroded from the very first years by the passiveness that girls are encouraged to adopt, the discrimination between boys and girls, the socially determined and assigned roles that are offered to them and the absence of viable feminine models. History and the history of science and technology in particular, when we think of it, is taught to us entirely in the masculine gender. The name of Marie Curie who was awarded the Nobel Prize twice in physics and chemistry comes foremost in mind to prove this falsification of the real contribution of women. She was not admitted to France's Academy of Sciences, although her husband was who earned only one Nobel Prize. Similarly Amalie Emmy Noether, a notable mathematician, who did important mathematical work in the area of pure mathematics was denied lecturership in the Philosophical Faculty of Gottingen due to her sex even though she had the support of the famous mathematician Hilbert. It is not common knowledge that the science and technology of farming was originally developed by women. Augusta Ada Byron, daughter of Lord Byron, worked with English mathematician Charles Babbage and developed the first computer programme.

The scarcity of 'famous women', the discrimination to which they are subjected and their inevitable depreciation have very important consequences for women. The system perpetuates itself by the absence of models with which women can identify themselves. The fact that another woman from the Curie family, Irene Joliot Curie has left her name in the history of physics demonstrates the importance of models!

One should remember that more than 80% of all scientists and 90% of technologists only participate in routine work feeding the rest with data which makes possible scientific and technological advance. It has never been argued that these majority of male scientists and technologists have not gone higher or done exceptional work because of their sex or family commitments. But the male dominated society ascribed such reasons in case of women. There is no correlation between sex and scientific productivity. No attempt is made by the scientific establishments to lessen the household drudgery for most women, even in urban areas not to talk of rural areas. Women are considered as a readily disposable scientific labour force. It is reflected in the abundance of women in lower echelons of scientific hierarchy, for example research project fellows, teachers and research assistants.

The second aspect of science and technology is how it affects women's lives. It all depends on the goals of science and technology policy which are determined by who controls and decides this. While two-thirds of all work in the world is performed by women, the 'non-working housewife' definition is a condition for unlimited exploitation of women in and out of home. In the present state of technological development, the encouragement of domestic industries and handicrafts based on women labour, as is being advocated by many centres of rural development in the country, is only another burden on the rural women folk. These products are invariably used either in urban areas or exported. The division of labour in modern technology invariably earmarks the most backbreaking drudgery to the women as is borne out by the work of nurses, primary school teachers, watch and electronic assembly units, telephone operators, secretaries, etc. The question of priority and direction in science is of utmost importance to women. The firing of an artificial satellite does not even remotely solve the daily problem of fetching water and firewood for the rural women or that of basic health care for them and their children. The science and technology for the latter is both cheap and available but there is dearth of will to improve the condition of women. There is need to discriminate, to choose, to exert on overall cultural screening—the right to choose a type of technological creation that originates from the people and is useful to the people—a technology emphasising the satisfaction of a public or mass need as opposed to individual consumption.

Another important aspect is inculcation of a scientific attitude and temperament. Most women, including educated ones, are prisoners of ignorance, superstition and age-old rituals. Although this applies to men as well, the burden of ritual is more on women in our society than on men. It becomes the duty of women in science and technology to make an organized effort to eradicate these evils from their sisters.

The ultimate goal of women in science and technology is not number but any person should be allowed and encouraged to pursue on education and career in whatever field he or she chooses based on ability, commitment, performance and without regard to age, sex, religion and politics.

## References

1. Garfield, Eugene. "Why Aren't There More Women in Science?". *Current Contents*, **13**, no. 17, 1982.
2. Rose, H. and Rose, S. *The Radicalisation of Science.*
3. Kimberling, Clark H. "Emmy Noether". *The American Mathematical Monthly*, **79**, no. 2, 1972.
4. Neumann, B.H. "Byron's Daughter". *The Mathematical Gazette*, **57**, 1973.
5 Cole, J.R. *Fair Science: Women in the Scientific Community.* New York: Free Press, 1979.

# The Role of Experiments and Improvisation in Effective Teaching of Physics at +2 Stage

O.P. SHARMA
K.J. KHURANA
**DESM, NCERT**
**New Delhi 110 016**

*The new course in physics of the NCERT introduced in 1988 also lays a greater emphasis on laboratory activities. The physics course now includes many topics like Electrostatics and Geometrical Optics (these were missing from the earlier courses), Semi-Conductor Devices which provide enough scope to strengthen the experiments in physics at the +2 stage.*

In 1976, the old system of higher secondary was replaced at the national level by the 10+2 system of school education. Since the demands of the subject of physics were much different in the new system and schools did not have the required resources, specially the equipment for demonstration and laboratory experiments, the teaching of physics was not well supported with demonstrations. Although, funds were made available to a large number of schools for the purchase of additional items of equipment required, the demand for various items required for an effective teaching of physics could not be identified by the Indian science equipment manufacturers who sought good export markets instead. In addition to this situation, attitude of the students and to some extent of teachers also, to lay emphasis on the mathematical treatment of physics and memorisation of facts could not create enough interest for experiments. The examination system has also been responsible to a large extent in leading to such a state. This is not a healthy situation, as teaching of science and specially physics needs to be supported by activities, demonstrations and laboratory experiments. A good deal of efforts, therefore, have to be made to popularise experimentation through demonstrations, activities and meaningful laboratory experiments.

The new course in physics of the NCERT introduced in 1988 also lays a greater emphasis on laboratory activities. The physics course now includes many topics like Electrostatics and Geometrical Optics (these were missing from the earlier courses), Semi-Conductor Devices which provide enough scope to strengthen the experiments in physics at the +2 stage. In addition to the textbook, laboratory manuals (8) have also been published, so as to provide necessary guidance to the teachers for organising demonstrations, activities and laboratory experiments to make the teaching effective. In spite of this the teachers often feel handicapped due to lack of proper equipment and facilities.

The purpose of this paper is to suggest to those interested in making physics teaching effective, some of the innovative items of equipment and also provide some hints as to how to improvise items of equipment by using materials which are commonly available.

### Improvisation for Experiments

Improvisation of equipment for the purpose of practical work in physics may be classified in two categories: (i) looking for substitution of traditional equipment, and (ii) designing and construction of innovative apparatus which could be possible within the resources available in schools.

As an example for the first category, we take up a trolley. As we know, sufficient literature exists on the use of a pair of trolleys and also single trolley for demonstrations, activities and experiments to bring out ideas related to force, motion, work and energy. But unfortunately the teachers find it difficult to procure trolleys from the market. Some of the leading manufacturers are manufacturing the trolleys for supply abroad (to West Asia and other developing countries) but are not interested in their supply to schools within the country. Roller skates easily available in the market can serve as a substitute for the trolleys. A skate has four wheels compared to the three-wheel trolley used for physics experiments. This point has to be kept in mind while using a skate in place of a trolley. A suitable spring and a matching aluminium tube have to be purchased and fitted firmly on to one of the skates to use it as a trolley with a spring. The present course in physics envisages a large number of experiments using a single trolley with a ticker tape timer or a pair of trolleys. There are several other examples of improvisation of this type where a single item of equipment plays a multiple role in the teaching of physics and can be improvised easily.

Sometimes it is possible to replace a costly and sophisticated piece of equipment by a simple item, of course by compromising with accuracy to some extent. The topic of elasticity can be well supported with interesting demonstrations, activities and laboratory experiments instead of having just one sophisticated Searle's experiment. One suitable rubber spring* provided with an improvised strong hook and a mm-graph scale can be used to demonstrate and also to study Hooke's Law in a simple way. Moreover, the changes in length of a rubber string at the time of loading (unloading) are quite large as compared to a steel wire and therefore allow a direct measurement by reading the position of the pointer attached near the lower end of the string (Fig. 1).

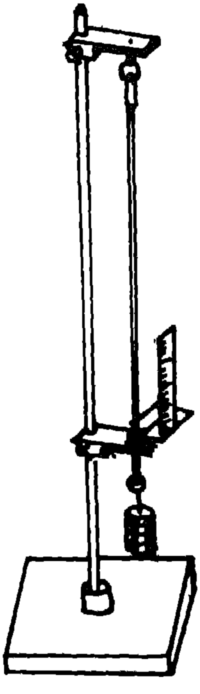


**Fig. 1.** *A view of the innovative apparatus to explore the Hooke's Law and to find Young's modulus of rubber for the string used.*

---

* Usually a notion exists that rubber is not an elastic substance But a suitably selected rubber spring serves the purpose well within the elastic limit.

Similar other examples are the use of a large semitransparent injection syringe, say, 30 ml (or a glass syringe will also do but would need more care) for study of Boyle's law; and the use of a cleaned fused fluorescent tube for replacing the commercial apparatus for study of viscosity (terminal velocity). The latter may also be used for other experiments like the resonance in a closed organ pipe.

In this category, we may also include the use of some toys like:

- a pistol shooting out solid plastic bullets or balls for the study of projectile motion.
- a drinking duck for demonstrating concepts like stable and unstable equilibrium, evaporation causes cooling, phase change of alcohol from liquid to gaseous state.
- an air puck with a balloon commercially sold as a toy.
- large steel coil (slinky) sold as a toy for demonstrating wave motion.

Such selected toys not only make the students enjoy the experiments but are very instructive, if used properly.

The second category of improvisation, as mentioned earlier, involves the construction of an apparatus by using the materials readily available around us. For example, an inertial balance can easily be improvised using a piece of a used hacksaw blade or a thin metallic strip (Fig. 2). Not all the hacksaw blades lend themselves to this use. This innovative item can be used to determine the inertial mass of small objects (of say 50 g). Several schools have already improvised this item in their laboratories. This is such a simple apparatus that it can also be prepared at home by a student.

Other examples of this type of improvisation are a metre scale as a bar pendulum (4), double inclined track, rotating turn table (8), and a set-up to demonstrate that the moment of inertia of a rod depends upon the mass-distribution. Most items of such equipment can be used to perform more than one demonstration, activity and experiment related to different concepts of physics.

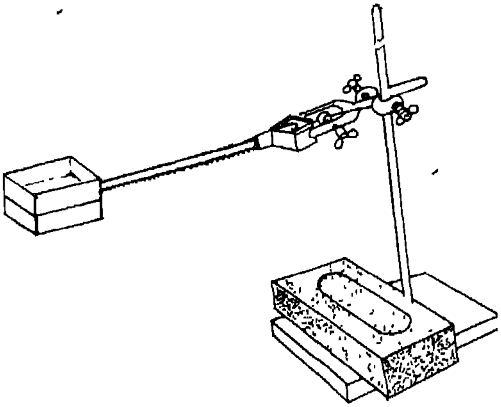


**Fig. 2.** *Experimental set-up to use an improvised inertial balance A small tray fitted at the free end is used for loading with masses up to 100 g. The masses when loaded are tightly packed to avoid any external effect on the vibrating hacksaw.*

It is not always necessary to have an item of equipment to create a learning situation for doing an activity/experiment. It is possible to provide many thought provoking situations to develop proper understanding of a particular concept using non-conventional items of equipment. The study of motion of a cylindrical glass or a translucent plastic bottle fully filled with sand, more than half filled, half filled, less than half filled and without any sand, may be very interesting. One can add another dimension to this study by filling the bottle with water instead of sand. The discussion on various aspects of motion of such an object and explanation of observations may be utilized to develop an understanding of the effect of 'latent' friction inside the bottle, rolling friction outside the bottle, centre of mass of the system (bottle and sand) and their combined effect on the motion of a body.

## Advantages of Improvisation

All those who have improvised an equipment at some stage or the other know how thrilling such activities are. Some of the advantages of improvisation are:

- An item of improvised equipment being simple and open in its design has an additional instructional value besides the motivation it provides to the users for trying their hands to pick up improvisation.
- There is hardly any maintenance problem.
- Minimises the problem related to market survey and procurement of items and also to some extent funds.
- Provides the students with the opportunity of using their head and hands together and to have proper linkage and understanding between theoretical and practical ideas.
- Provides an opportunity to the students for acquiring the basic skills and the confidence of crafting on their own.

## Conclusion

The present system of examinations has become very formal and has left hardly any room for creativity in the practical work of science in general and physics in particular. By encouraging the improvisation of the items of equipment the students may get an opportunity to give vent to their creative talent besides helping the schools to augment their laboratory facilities.

## References

1. Sant Prakash. "Suggestions for Improving Physics Laboratory Activities". *School Science*, Vol. XX, no. 2, 1982, p. 20.
2. Johnson Ekpo. "Improvised Materials as Alternative Equipment". *School Science*, Vol. XXV, no. 2, 1987, p. 1.
3. Bomide, G.S. "Science Teaching in a Period of Recession: The Need for Improvisation". *Journal of Science Teacher's Association of Nigeria*, Vol. 23, nos. 1 and 2, 1985, p. 34.
4. Ratna, Ved and Goel, V.P. "Metre Scale Bar Pendulum". *School Science*, Vol. XXVI, no. 3, 1988, p. 30.
5. Deka, A.K. "Physics Education from Toy Birdy". *Physics Education*, Vol. 5, no. 1, 1988, p. 12.
6. *Physics Laboratory Guide PSSC*, NCERT, New Delhi.
7. *New Trends in Physics Teaching*, Vols. III and IV, UNESCO, 1976, 1984.
8. *Physics Laboratory Manuals*, Vols. 1 and 2, 1989, NCERT, New Delhi.
9. *Source Book for Science Teaching*, chapter "How to Make Some General Pieces of Equipment", UNESCO.

# A Study of Order of Preference for Circuit Diagrams in Physics by Secondary School Students

LALIT KISHORE
**Principal**

H.S. PURI
**Post Graduate Teacher**
**Kendriya Vidyalaya**
**NFL Township, Bathinda**

---

*A special mention is necessary here to highlight the inappropriate circuit diagram of Ohm's Law of the NCERT Science Textbook (Balasubramaniam, D. et al., 1988) for Class IX which found the last preference both with the experts and the students in the present study. The following glaring defects are there in the circuit diagram in the NCERT book: there is no distinction between the connecting wire and resistance; no polarity marks have been shown for the battery and meters; the direction of current has not been shown.*

---

## Introduction

A diagram is a simplified drawing of an object, product, appliance or plan to explain some finer points of the same. A diagram is graphic aid to show relationship with the help of lines and symbols without the pictorial element Kishore (1989) emphasises that some diagrams are highly abstract, complex and technical and require some training to understand them.

It has been observed that diagrams are effective for summarizing and reviewing parts of a lesson. Many teachers prefer to draw diagrams on chalk-board during the course of lesson itself which can result in loss of efficiency in teaching.

Servey (1972) says that the diagrams found in textbooks, reference books and the more scholarly publications serve to clarify knowledge through concise expression, and such expressions are usually carefully keyed or labelled to aid comprehension.

He further adds that the use of accurate diagrams for information requires the application of relating the symbolized structure of the diagram to a real structure in an automatically exercised skill when the structure symbolized is part of children's everyday environment.

Further, Sharma and Moquemuddin (1987) observe that diagram is an explanatory drawing that explains inter-relationship by using lines, geometrical forms and symbols. According to Jambunathan (1986) a diagram is an abstract representation of a complex thing where the pictorial elements are absent.

In the chapter on electricity in physics, the teacher has to make use of circuit diagrams with various symbols to represent different electrical components and connections. A cursory glance of various textbooks revealed that the diagrams of the Ohm's Law circuit differed from book to book.

Therefore, an attempt was made to study longitudinally the preference rank orders for circuit diagrams of two groups of students at grade levels IX (13+) and XI(15+). These grade levels were chosen as at Class IX level formal introduction of electrical circuit is taken up seriously and at Class XI level the students get two years' exposure to diagrams.

### Objectives of the Study

1. To analyse the standards of circuit diagrams in some Indian and foreign textbooks.
2. To find the students' rank correlation of preferences for circuit diagrams as compared to experts' preferences.
3. To study longitudinally the change in the students' preference for circuit diagrams.
4. To collect students' comments on the preferences for circuit diagrams.

### Design of Study

The circuit diagrams of Ohm's Law from ten different foreign and Indian books were pasted on a chart paper and their numbering was done. These circuit diagrams were exposed to the students at different times. Two groups of Class IX (13+, $N = 30$) and XI (15+, $N = 28$), studying at K.V. No. 2, Bathinda formed the sample for the present study.

The students were asked to write the preference order on the basis of the illustrative value of the circuit diagrams. They were given a time of 45 minutes to minutely study the diagrams for this purpose.

Also, the students' comments were collected on loose sheets of paper for selecting the best circuit diagram.

In order to compare the preference rank order of students the reference order was formed on the basis of unanimous decision of six physics teachers. The rank correlation technique was employed to find the longitudinal changes in preference for diagram by students for the best three chosen diagrams.

### Analysis

The descriptive statistics of ranks given by experts and students of Classes IX and XI are shown in Table 1 and Table 2 respectively.

From the descriptive data of Tables 1 and 2, the rank correlation was found for the two groups of students and the same is shown in Table 3.

Table 3 reveals that the students of Class IX (13+) show a negative correlation and cannot

**TABLE 1**
**Summary of Preferred Orders of Experts and Students of Class IX**

| | | | |
|---|---|---|---|
| Reference circuit preference rank order | 1 | 2 | 3 |
| Class IX circuit preference rank order | 5 | 1 | 4 |

**TABLE 2**
**Summary of Preferred Orders of Experts and Students of Class XI**

| | | | |
|---|---|---|---|
| Reference circuit preference rank order | 1 | 2 | 3 |
| Class XI circuit preference rank order | 1 | 3 | 2 |

**TABLE 3**
**Summary of Rank Correlation of Class IX and Class XI Students with Reference to the Experts' Ranks**

| Class | No. of Students $N$ | Rank Correlation |
|---|---|---|
| IX | 30 | -3.5 |
| XI | 28 | +0.5 |

distinguish properly between good and bad circuit diagrams. On the other hand, the students of Class XI (15+) who had earlier experience of two years in circuit drawing and making showed a positive correlation in choosing the right circuit diagram.

Some of the typical comments of students for top preference for a particular circuit diagram are as follows:

1. I prefer this circuit diagram as it shows the proper place of battery, voltmeter, ammeter and resistance wire.
2. I prefer this particular circuit as the distinction between resistance wire and connecting wire has been shown properly.
3. I prefer circuit diagram No. 10, since it gives a clear picture of proper terminals, symbols of various appliances and direction of current.

## Conclusion and Discussion

The following conclusions are drawn from the present study:

1. The students who are new to circuit diagram analysis do not show a positive correlation while choosing the right circuit diagram.
2. With age and experience, the students develop a positive correlation while choosing the circuit diagram.
3. The circuit diagram in a good majority of books were found to be lacking in proper representation of direction of flow of current, polarity of meters and symbolic representation of correcting and resistance wires.

The findings of the study clearly indicate that there is a need for special training of students in analysing the circuit diagrams at the stage the electrical circuits are introduced is school. At least, this could be done at Class IX level when formal introduction of electrical circuit is done both in theory and practicals.

A special mention is necessary here to highlight the inappropriate circuit diagram of Ohm's Law of the NCERT Science Textbook (Balasubramaniam, D. et al., 1988) for Class IX which found the last preference both with the experts and the students in the present study. The following glaring defects are there in the circuit diagram in the NCERT book: there is no distinction between the connecting wire and resistance; no polarity marks have been shown for the battery and meters; the direction of current has not been shown.

Servey (1972) says that when the diagram symbolizes a structure unfamiliar to children, the teacher must guide carefully in establishing referents. Interpreting the diagram labels or key is a skill requiring practice so that the children are able to use diagrams independently. Children should be guided to examine the labels on a diagram one by one to relate the items and functions depicted therein.

## References

1. Eyre, E.C. *Effective Communication Made Simple.* London: Heinemann Publications, 1983.
2. Jambunathan. *Educational Technology.* Annamalai: University of Annamalai, 1986.
3. Kishore, L. *A Textbook of Audio-Visual Aids.* Manuscript under Publication. Delhi: Doaba House, 1989.
4. Servey, R.E. *Social Studies Instruction in the Elementary School.* New Delhi: Thomson Press (India) Ltd., 1972.
5. Sharma, S and Moquemuddin, M. *Audio-Visual Educations.* Ludhiana: Prakash Brothers, 1987.

# Science News

## Lung Cancer Gene Discovery

Scientists at two of the Imperial Cancer Research Fund's laboratories, one at Potters Bar near London and the other at the John Radcliffe Hospital in Oxford, have reported a discovery which, according to the ICRF, opens up new possibilities for treating lung cancer.

Reporting in a recent issue of the London medical journal *Lancet*, the research team say they have found a changed form of the p53 gene in nearly all the tumour tissue from smoking-related cancers they studied. The gene was normal in healthy lung tissue from the same people.

There are three cancers known to be smoking-related, namely squamous carcinoma, adenocarcinoma and small-cell cancer. The vast majority of lung tumours have been found to share the same genetic abnormality; the only exception found was in the very rare carcinoid tumour, which is not caused by smoking.

P53 controls cell multiplication. When it is damaged, runaway growth results, giving rise to a tumour. The highest levels of abnormal p53 were found in small-cell lung cancer, which accounts for some 25 to 35 per cent of the disease and where tumour growth is the most rapid.

Dr David Lane, Head of the ICRF's Molecular Immunochemistry Laboratory at Potters Bar says: "Obviously, it will be some time before this finding can be translated into new therapies. But it does offer new and logical routes to treating lung cancer—perhaps the possibility of targeting the changed gene with a poison to knock it out, or perhaps we can copy the action of the normal p53 gene to regain control."

All our genes come in pairs, one inherited from each parent. With most of the genes involved in cancer, both of those making up the pair need to be damaged in separate events for cancer to start. It seems that p53 behaves differently. Dr. Lane said: "In this case, we think damage to only one of the pair is needed to start the process, and this changed version binds to the normal one, inactivating it."

The p53 gene was identified by Dr. Lane and Dr. Lionel Crawford when they were working at the ICRF's central London laboratory in the late 1970s. Recently scientists at ICRF and in other laboratories across the world have shown that the faulty version is involved in many forms of cancer, including those of the breast and bowel. These, with lung cancer, are the three main cancer killers in the western world, and Dr. Lane believes p53 might also play a part in other forms of the disease

He added: "Cancer is a multi-step process, with other genes involved in a domino effect along the way. But if we can find one point where we can successfully intervene, with a tailor-made treatment using our growing understanding of how p53 works, we might be able to restore normality and halt the cancer process."

## Medicines for Parkinson's Disease

Scientists report they have cloned a gene that helps brain cells communicate a step that may lead to improved schizophrenia drugs and quicker diagnosis of some brain diseases. The finding may someday let doctors diagnose schizophrenia and Parkinson's disease before symptoms appear. That could allow earlier treatment with greater chance of success.

The new work is reported in a recent issue of the British journal *Nature* by three teams of scientists.

The gene tells brain cells how to make a protein structure called a dopamine receptor. The receptor sits on the surface of brain cells and receives chemical messenger called dopamine that brain cells send one another.

The newly cloned gene is for the so-called "DI dopamine receptor." The gene for the other kind of dopamine receptor called D2, was cloned in 1988.

Dr. Dearry of the Duke University Medical Centre said the discovery may lead to a test to detect very early cases of schizophrenia or Parkinson's disease by revealing receptor abnormalities.

Parkinson's disease is a potential disabling condition that can include a tremor, rigidity and gradual loss of spontaneous movement. Further work also may pave the way for better drugs to treat psychosis, the loss of touch with reality seen in schizophrenia, Dr. Dearry said.

Scientists may be able to distinguish different variants of the receptor, and design drugs to act only on those variants that affect psychosis while avoiding variants that produce side effects.

The new work is important because it allows new studies of the DI receptor, commented Fr. Arnold J Friedhoff, psychiatrist and director of the Millhauser Laboratories at the New York University Medical Centre.

## Jupiter's Clouds Changing Colour

A 9,976 km wide belt of clouds on the planet Jupiter is starting to change back to its typical dark brown smoggy colour, thirteen-and-a-half months after it turned white, astronomers said.

Several astronomers from NASA's infra-red telescope facility on Hawaii's Mauna Kea Volcano and from various observatories around the world reported the change. The reports went to the International Astronomical Union's central bureau for astronomical telegrams, an astronomy reporting agency, in Cambridge Massachusetts, USA.

In July 1989, the British astronomer Mr G.M Hurst, first noticed that Jupiter's 6,200-mile wide southern equatorial belt was changing brown to white and growing colder. But during the past many weeks astronomers have observed the cloud belt on the solar system's largest planet starting to warm and turn brown again, according to announcements.

The belt turns white when Jupiter's internal heat pushes enough ammonia ice crystals upward in the atmosphere, where wind blowing over 300 mph (483 kph) spreads the crystals out to form a white deck of light-reflecting cirrus clouds.

The cloud belt changes brown when violent storms mix Jupiter's atmosphere, allowing sunlight to trigger chemical reactions between ammonia and atmospheric methane gas. That creates brownish photochemical smog that drifts down in the planet's atmosphere.

If history repeats itself, Jupiter's great red spot—a hurricane almost twice the size of earth—soon should become less red. When the southern equatorial belt turns brown, wind eddies feed ammonia ice crystals into the great red spot, washing out some of its red colour.

The cloud belt sits just north of the great red spot. When the cloud belt turns white, the eddies diminish, reducing the amount of ice entering the great red spot and allowing it to turn darker red.

## Super Hole to be Dug in the Earth

Scientists are all set to dig a hole in the earth. According to a report in a recent issue of the British science journal, *Nature*, the hole to be drilled in northern Bavaria in West Germany will be 10 km deep and will expose an unexplored part of the earth's crust. Drilling will begin soon and be completed in 1994.

The Bavarian hole is among the many that have been dug in the earth for more than a century. The cost is estimated to be about $256 million.

The earth's deepest hole is situated in the Kola peninsula of the Soviet Union and is 12 km deep. The first hole, reaching only 21 metres, was dug in Titusville in Pennsylvania, USA, in 1859. But at present, if holes for oil and gas exploration in the USA between 1970 and 1985 were laid end to end, they would reach more than twice to the moon and back, according to one report.

The idea, technology and the money behind the super holes signify an ongoing effort to unravel mysteries about the history of the earth that have puzzled scientists through the centuries.

However, despite all efforts, rocks recording the history of the first billion years of the earth have rarely been found. But the super deep holes have managed to gather evidence of how the continents subsequently formed and evolved through the addition of molten material from the bowels of the earth.

The super holes have also provided evidence of how the continents have been reshaped by repeated collisions and subjected to an array of violent processes—like massive riftings.

Drilling holes has had its share of problems. The combined knowledge of geophysics and geology complemented by hi-tech tools have in many cases been found sorely wanting in delivering the goods.

Another difficulty relates to the matter of predicting the kind of structure a drilling will encounter. For instance, the Bavarian hole was intended to go 14 km deep but the idea was abandoned as the pilot hole encountered an unexpectedly high temperature of 118°C at 3.5 km, much more than what was expected. Also, in many cases fluids have been found between layers of rock where none were thought to exist.

## Butterfly Population Dwindling in U.K.

The butterfly population has declined substantially because many traditional habitats have almost disappeared, a study says. About three-quarters of the 59 varieties of butterfly resident in Britain 150 years ago have been affected. Four have become extinct and a further seven are threatened with extinction

Two experts Martin Warren and Trevor Lawson reported in Green Magazine that the losses follow a decline in traditional woodland management. Coppicing, a practice of keeping small areas small trees, encouraged butterfly colonies. Now this is practised in only 2% of woods, the rest are too shaded for most butterflies.

One of the worst affected is the *Heath fritallary*, whose numbers have declined by 82% since 1910. The Prince of Wales has established a reserve in Cornwall but its future is precarious. It is crucial to introduce more open habitats into forests, preferably combined with the use of native small trees and that it is vital to maintain traditional coppicing.

Ian MacLean, of the Nature Conservancy Council believes that only wider conservation policies through which one could rebuild major features such as hedgerows, verges and meadows, might save in the long run not only butterflies but bumble bees, crickets and grasshoppers also.

## INSA Award for Narlikar and other Scientists

Noted astronomist Jayant Vishnu Narlikar has been awarded this year's Indira Gandhi prize for popularization of science by the Indian National Science Academy.

Prof. Narlikar, who is the Director of the Inter-University Centre for Astronomy and Astrophysics at Pune, has been awarded the prize for his "outstanding contribution to popularization of science through articles, books, films and programmes on television," according to an INSA release. The prize is awarded once in two years.

Meanwhile, the 1989 Darashaw Nosherwanji Wadia medal for outstanding contribution in earth science, geology, geophysics and geography has gone to Prof. Saurindra Nath Sen, formerly head of the Department of Geology at Calcutta University, for his "outstanding contribution in the field of structural and tectonic interpretation of the precambrian rocks of Rajasthan."

In other awards announced by INSA, the Endowment Lecture awards for 1990 have gone to Professor Chunni Lal Khetrapal, Indian Institute of Science, Bangalore; Prof. Divya Darshan Pant, INSA senior scientist, Allahabad; Prof. Ishwar Prakash, Central Arid Zone Research Institute, Jodhpur; Dr. Verghese Kurien, Chairman, National Dairy Development Board, Anand and Dr. Sukh Mahendra Singh, Benaras Hindu University, Varanasi.

The subject-wise medals for 1990 have been awarded to Dr. P.K. Iyengar, Chairman, Atomic Energy Commission, Bombay; Prof. P.R. Pisharoty, Physical Research Laboratory, Ahmedabad; Prof. C.M. Srinivas Dass, University of Delhi, Delhi; and Prof. Gitindra Saran Sanyal, Indian Institute of Technology, Kharagpur.

The endowed medals for 1990 have gone to Prof. H.Y. Mohan Ram, Delhi University, Delhi and to Dr. Arno A. Penzias and Dr. Robert Woodrow Wilson of AT&T Bell Laboratories, USA.

The medals for academy lectures for 1990 have gone to Dr. Nihal Kishinchand Notani, Bhabha Atomic Research Centre, Bombay, and Prof. Mrinal Kumar Das Gupta, Kankurgachi, Calcutta.

## Biorhythm Helps Avoid Air Accidents

The critical phase of "biorhythm" of pilots could account for a good number of accidents of Indian Air Force aircraft, according to a study by a group of specialists in aerospace medicine.

The concept of "Biorhythm" suggests that every individual's performance is controlled by three cycles—a 23-day physical, a 28-day emotional and a 33-day intellectual cycle. These cycles begin at birth and encompass positive and negative phases (when the performance is good and poor respectively).

The study group, led by Wg. Cdr. G.S. Nayar, says that preliminary studies have shown a correlation between the biorhythmic criticality and the occurrence of air accidents among the IAF aircrew. The study, "Biorhythmic Criticality and Occurrence of Accidents," was presented at the 32nd annual conference of the Indian Society of Aerospace Medicine in Bangalore.

Wg. Cdr. Nayar told the conference that two studies conducted by his team indicated the relationship between the pilots biorhythmic criticality and air accidents. The present one, covered 10 aircrashes (five of which were fatal) in the 1988-90 period in the South Western Air Command. Of these, eight crashes occurred on the pilots' critical day.

An analysis of data pertaining to ground and aircraft accidents involving 138 aircrew members also showed that the biorhythmic hypothesis could not be ignored

Wg. Cdr. Nayar proposed a full-fledged one-year study, covering all the pilots of the air force to establish the role of biorhythm in air mishaps. If its role was established, the squadron flight commanders should be told to draw up flight schedules in such a way that a pilot was not assigned a sortie on his critical day.

Wg. Cdr. Nayar said physical and emotional cycles were considered to be closely related to accident causation. The possibility of predicting human performance capacity was explored in various fields like the industries, road traffic management and aviation with conflicting claims. Though its role in predicting accidents was not clearly established, it was being applied in some countries to prevent mishaps.

Wg. Cdr. Nayar said the United Airlines had reported that accident and injury rates were halved among the maintenance staff because extra precautions were taken during the critical phases of biorhythm.

An industry in Switzerland had claimed that accident rates came down by as much as 70% by employing the same technique. The Japanese had even developed wrist watches that warn motorists of the critical days so that they are cautious during driving, he added.

## No Evidence of Global Warming

A new satellite study of world temperatures over the past decade has found no evidence of the global warming trend predicted by many scientists. The new finding is certain to fire up the debate in scientific community whether world temperatures are actually on the rise.

The latest report on global temperature trends is—according to its authors, a team of researchers from the National Aeronautics and Space Administration and the University of Alabama, Huntsville—the most reliable yet prepared. It relies on data gathered by a series of satellites launched into the upper atmosphere in late 1978 by the U.S. Commerce Department's National Oceanic and Atmospheric Administration

"While future global temperature variations were not specifically addressed, the decade from 1979 through 1988 showed no net warming or cooling trend," NASA said, summing up the report.

The government satellites were equipped with devices able to measure the temperature in a layer of air 965 km wide and 1,524 metres to 6,096 metres above sea level a slice of the upper atmosphere where scientists predict the first signs of global warming will appear.

Instead of a steady warming trend, the researchers found a seemingly random pattern of change from year to year.

"The warmest year was 1987, and the next warmest was 1988, but the average of the first five years—1979 to 1983 was warmer than the most recent five," said Mr. John Christy of the University of Alabama's Johnson Research Centre.

The years 1984, 1985 and 1986 were the coolest of the decade, Mr. Christy and the fellow researcher Mr. Roy Spencer of NASA said.

The satellite data is superior to land-based systems because temperatures recorded by ground-based thermometers are concentrated near population centres, leaving the oceans and vast regions of remote desert, rain forest and mountains unmonitored, the researchers said.

## Gene that Raises Cancer Risk

A gene that may be carried by one out of 10 people could make them more susceptible to lung cancer, according to a study. "The findings were published in the latest issue of the journal of the National Cancer Institute."

"There is only a suggestion that this gene exists," admits Mr. Joan Bailey-Wilson. "If it does and a person with this gene smoked, the risk of getting lung cancer would be increased tremendously." "It doesn't mean a person with this gene would," Mr. Bailey-Wilson clarified. "It would mean, they are much more susceptible to environmental factors."

The scientists at Louisiana State University Medical Centre in New Orleans have yet to confirm the existence of the gene, but their survey of 4,357 people strongly supported their theory the gene exists, Mr. Bailey-Wilson said.

The findings don't lessen the role the environmental factors, such as, smoking are believed to play, Mr. Bailey-Wilson added.

## 2000 Years Burial Site Unearthed

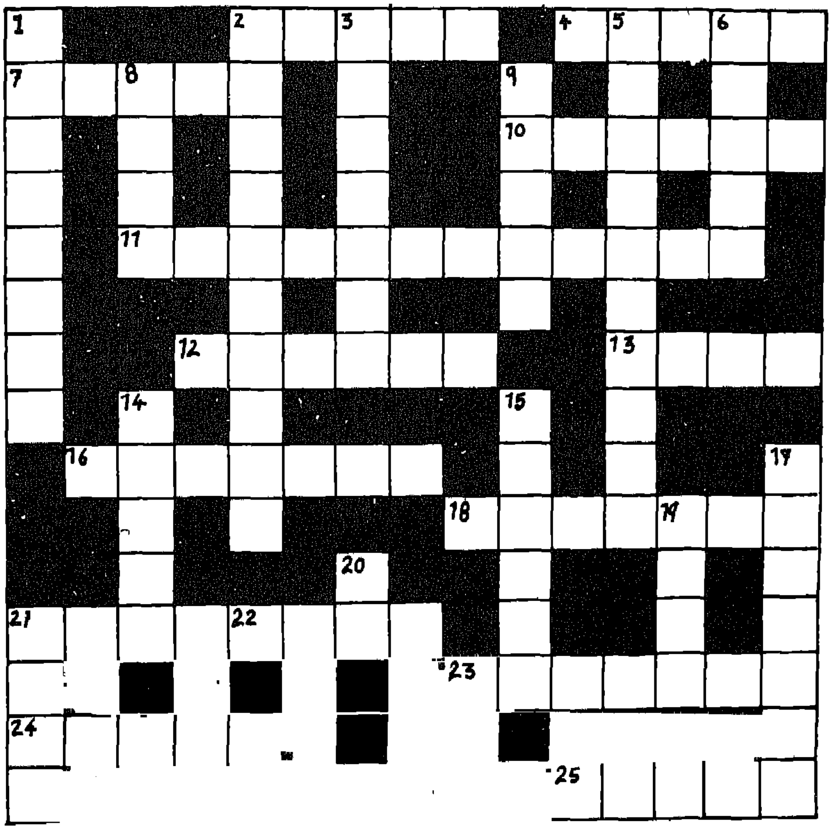
Archaeologists have unearthed a 2,000-year old burial site containing 40,000 pottery figurines, more than five times the number of famed terracotta warriors found earlier in the ancient capital of Xian.

The newly discovered site, also in Xian, the provincial capital of Shanxi, dates back to the Han Dynasty (220 B.C–206 A.D), the *Xinmin Evening News of Shanghai* reported.

The archaeologists already have uncovered 11 pits in the past two months. Each pit measures an average of four metres (13.2 feet) wide, seven metres (23.1 feet) deep and dozens of metres (yards) long, the paper said.

More than 300 figurines excavated so far are all male, naked and about 60 centimetres tall, it said.

# Crossword Puzzle



## Clues

*Across*

2. Element with lowest two digit atomic number (5)
4. Every object occupies it (5)
7. The path of a satellite (5)
10. Positively found in a nucleus (6)
11. Distance with direction (12)
12. An exposition of principles of science (6)
13. A basic dimensional quantity (4)
16. A prism does it to a beam of incident light (7)
18. Unhealthiness of a living body caused by an agent (7)
21. A type of micro organism (8)
23. Basic cellular process for growth and maintenance of living organism (7)
24. A condition due to deposition of excessive fat (5)
25. Undesirable plants (5)

*Down*

1. Class of compounds formed by sharing of electrons (8)
2. Envelops the earth (10)
3. Italian scientists who invented gas thermometer (7)
5. A body thrown at an angle (10)
6. It can be converted into a kitchen garden (5)
8. Formed by transfer or sharing of electrons (4)
9. Magnitude of velocity (5)
14. They do it for reuse of waste (7)
15. Non-living component of the biosphere (7)
17. Process of cell division accompanied by reduction in cromosome number (7)
19. Makes defenceless against diseases (4)
20. Prescribed course of meal (4)
21. A large terrestrial ecosystem (4)
22. Optical instrument in the human body (3)

RAJENDRA JOSHI
*DESM, NCERT*
*New Delhi*

# Book Review

## Physical — An Activity Approach to Physics

Brian Martin and Cornelis Spronk,
J.N. LeBel Enterprises Ltd., 249 Trade Zone
Dr., Ronkonkoma, NY 11779, U.S.A.

It is a textbook of the 90s in physics. It is only one component of the complete curriculum package consisting of (i) Text, (ii) Teacher Reference Manual, (iii) Solution Manual, (iv) Student Exercise Book, (v) Computer Disk, (vi) Computer Test Programme, (vii) Resource Enrichment Book and (viii) Chapter End Test Programme.

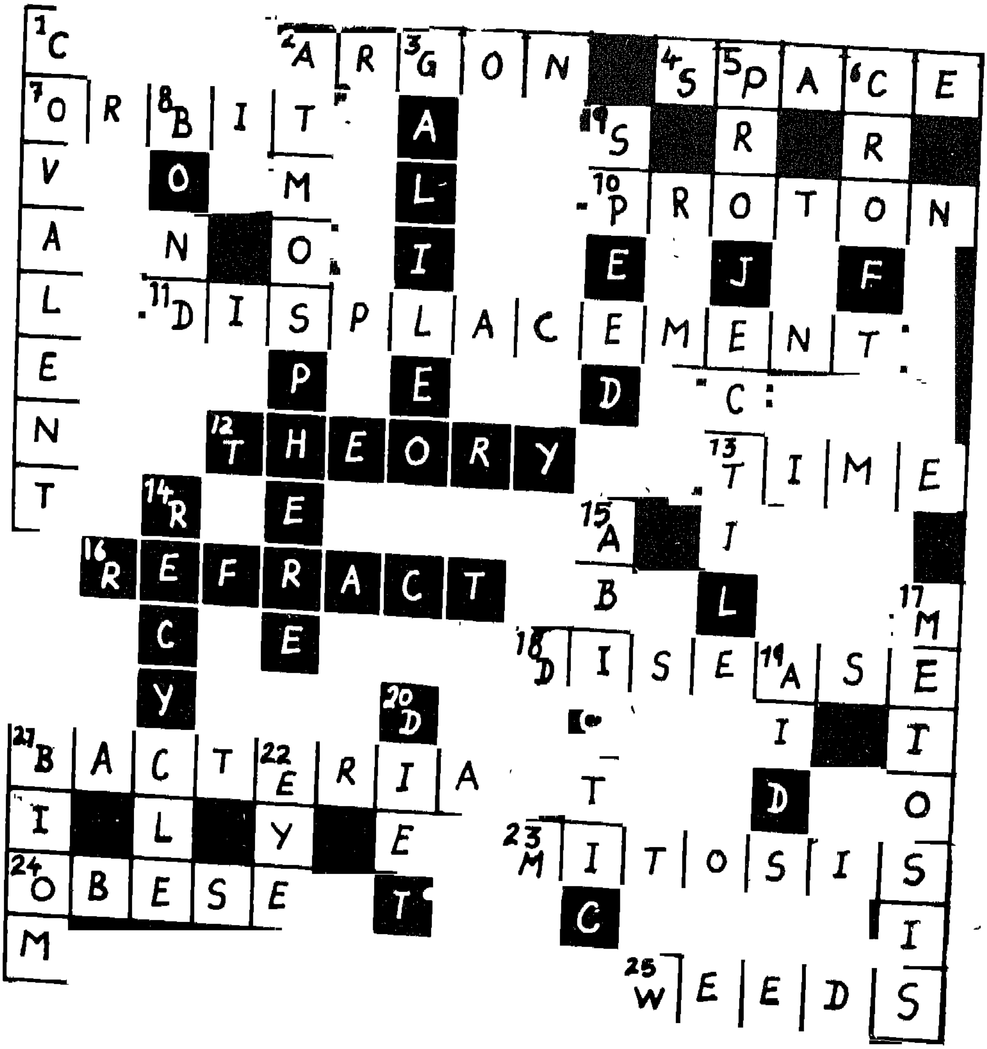
This curriculum is the outcome of many years' hard work in consultation with Professor Herbert H. Gottlieb who worked at Science Education Department, City College of New York for 30 years. The authors themselves being full-time classroom teachers claim that all materials have been classroom tested (in U.S.A., of course).

This curriculum makes good and very meaningful use of the modern tools like computer, which are now gaining entry into schools. There are also short programmes written in BASIC and listed in the text for students to use. They are intended to do specific tasks that relate directly to a topic within the text. But, this does not imply neglect of very simple low-cost experiments wherever these are useful. In fact, the experiments and activities seem to favour the use of simple, "home made" equipment that is easily within the budget of any school and can be improvised/fabricated within the school. Such apparatus eliminates the "black box syndrome" which can occur when students use complex equipment as a black box, not knowing what it is inside. It uses the SI system and only the SI units throughout. Thus it trains the student to think "metric".

As is usual with books published in the U.S.A., style of presentation is such that may be expected to create an excitement and a desire to study physics. There are sufficient diagrams and illustrations. Mathematical intricacies have not been given so much importance and physics is prime. This book, however, seems to excel in one respect. It gives many actual photographs of situations in everyday life and their interpretations with the help of sketches, which are based on basic principles of physics. Whereas the main text is addressed to the average student, it provides much additional material in margins to cater to the interests of the more gifted.

A word of caution is, however, necessary in using this curriculum package. In regard to practical work the ready-made tables provided seem to be too much. Students have to just fill in a few blanks. It may make practical work rather mechanical and one may not develop ability to design one's own experiment or even to design one's own observation table for an experiment, the procedure of which has been exactly described for him. There is certainly a merit too in such "standardised" experimental work. Such tables enable the teacher to conveniently and quickly read and evaluate the lab record and give instructions to individual student as to what part of experiment he/she has not properly done. Such practical work needs to be supplemented by some practical work where one designs one's own table and also some practical exercises where one designs one's own experiment.

S.K. VASIL
*Vice Principal, Govt. Coed. S.S. School*
*Khichripur, Delhi 110 092*



# SCHOOL SCIENCE

Vol. XXVIII No. 4 DECEMBER 1990

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

SCHOOL SCIENCE is a quarterly journal published by the National Council of Educational Research and Training. Intended to serve teachers and students in schools with the recent developments in science and science methodology, the journal aims to serve as a forum for the exchange of experience in science education and science projects. Articles covering these aims and objectives are invited. Manuscripts, including legends for illustrations, charts, graphs, etc. should be neatly typed double-spaced on uniformly-sized paper, and sent to the Editor, SCHOOL SCIENCE, Department of Education in Science and Mathematics, NCERT, Sri Aurobindo Marg, New Delhi 110 016 Each article may not normally exceed ten typed pages.

The articles sent for publication should be exclusive to this journal.

Illustrations may be limited to the minimum considered necessary, and should be made with pen and indelible Indian ink. Photographs should be on glossy paper, at least of postcard size, and should be sent properly packed so as to avoid damage in transit.

## EDITORIAL ADVISORY COMMITTEE

*Chairman*
Dr K. Gopalan
Director
NCERT, New Delhi

*Members*
Prof. A.K. Sharma
Joint Director
NCERT, New Delhi

Shri J. Veeraraghavan
Special Secretary, Ministry of
Human Resource Development
Govt. of India, New Delhi

Prof. Satya Bhushan
Director
National Institute of Educational
Planning and Administration
New Delhi

Additional Secretary
Ministry of Human Resource
Development, Govt. of India
New Delhi

Prof M.R. Bhide
Poona University
Pune

Prof Rasheeduddin Khan
Jawaharlal Nehru University
New Delhi

Prof. L.S Kothari
University of Delhi
Delhi

Prof. Durganand Sinha
Former Director
A.N. Sinha Institute of
Social Studies
Patna

Prof. R N. Ghosh
Central Institute of English
and Foreign Languages
Hyderabad

Prof. Namwar Singh
Jawaharlal Nehru University
New Delhi

Dean (Academic)
NCERT, New Delhi

Dean (Research)
NCERT, New Delhi

Dean (Coordination)
NCERT, New Delhi

Shri C N. Rao
Head, Publication Department
NCERT, New Delhi

Head, Department of Teacher
Education, Special Education and
Extension Services
NCERT, New Delhi

Prof. B. Ganguly
Head, Department of Education in
Social Sciences and Humanities
NCERT, New Delhi

*Convenor*
Prof R.P. Singh
Head, Journals Cell
NCERT, New Delhi

## EDITORIAL GROUP

Chief Editor B. Ganguly, General Editor R.P. Singh, Executive Editor: D. Lahiry
Members: R C. Saxena, K M. Pant, Rajendra Joshi, J.S. Gill
Editor: G.L. Anand, Chief Production Officer: U. Prabhakar Rao
Production Officer: D. Sai Prasad, Production Assistant: Rajendra Chauhan
*Cover Design.* D.K. Shende

## SUBSCRIPTION

*Annual:* **Rs 16.00** *Single Copy:* **Rs 4.00**

A QUARTERLY JOURNAL
OF SCIENCE EDUCATION

# SCHOOL SCIENCE

Vol. XXVIII No. 4
December 1990

---

## CONTENTS

| | | |
|---|---|---|
| Philosophy, Computers and Mathematics | 1 | MARLOW EDIGER |
| Improvement of Science Education in Schools: Indian Context | 6 | B. GANGULY |
| Identification of Misconceptions Related to Work and Energy Among Students | 14 | A B. SAXENA |
| Cognitive Preferences in Operation: An Example | 24 | JYOTI PRAKASH BAGCHI |
| A Multipurpose Coil for Experiments in Electro-Magnetism | 32 | VED RATNA |
| Planning Environmental Education at the National Level | 37 | |
| A Discriminatory Study of Achievement of Students in Physics Taught through Lecture Model and Individually Guided System of Instruction | 40 | LALIT KISHORE<br>B.K. AGGARWAL |
| Students' Query about the Number $\pi$ | 44 | SURJA KUMARI |
| Nobel Prizes in Science for 1990 | 49 | |
| Science News | 55 | |

## TO OUR CONTRIBUTORS

*School Science* invites articles from teachers, acquainting students with the recent developments in science and science methodology The articles should be addressed to Executive Editor, Department of Education in Science and Mathematics, NCERT, Sri Aurobindo Marg, New Delhi 110 016.

# Philosophy, Computers and Mathematics

MARLOW EDIGER
**Division of Education**
**Northeast Missouri University**
**Kirksville, MO 63501, USA**

*The mathematics teacher needs to study and analyze diverse schools of thought in the software/computer curriculum. Each philosophy has selected recommendations to make in teaching-learning situations The philosophy emphasized needs to harmonize with the personal learning style of a student.*

The mathematics curriculum needs to place heavy emphasis upon computer utilization. Software packages need to guide learners to achieve objectives Each software package should stress sequential subject matter to be acquired so that more optimal student progress in mathematics is possible. With quality sequence, learners should experience increased success when interacting with the content presented on the monitor Sequential learning emphasizes a relationship of new subject matter attained with that previously acquired. Knowledge that is related should be retained longer by students as compared to that which is fragmented. Quality software in mathematics should provide content which is correlated, fused and integrated with subject matter previously achieved.

Software content needs to capture student interest. Thus the student and the mathematics curriculum become one, not separate entities Subject matter then presented on the monitor attracts learner attention. Set establishment is in evidence. An inward desire exists by the student in wanting to achieve relevant objectives in mathematics.

Purpose needs to be in evidence to achieve vital facts, concepts, and generalizations in mathematics. The mathematics teachers may stimulate students, inductively or deductively, to accept reasons for learning. After purpose has been established, students need to be actively involved in achieving vital subject matter from the ongoing software presentation

Thus success in learning, student interest, as well as learner purpose in software/computer experience are a must in a quality mathematics curriculum.

## Philosophy of Education in Mathematics Software Utilization

The mathematics teacher needs to study and analyze diverse schools of thought in the software/computer curriculum. Each philosophy has selected recommendations to make in teaching-learning situations The philosophy emphasized needs to harmonize with the personal learning style of a student.

*First of all a problem-solving strategy* may be implemented in ongoing lessons and units Flexible steps of problem-solving include careful identification of a problem in mathematics The problem should be selected by students with teacher guidance in a contextual situation. Each problem is life-like and comes from the societal arena Thus the mathematics curriculum is not separated from society.

Information needs to be gathered in answer to the problem. Subject matter contained in relevant software might well be a part of the total needed information Other reference sources may also be utilized such as mathematics textbooks, workbooks and audio-visual materials A hypothesis results which is an answer to the problem. The hypothesis is tentative and subject to modification as a result of testing. A hypothesis is not absolute, but tentative in nature Salient software then has an important role to fulfill in the total problem-solving sequence and arena.

Problem-solving strategies in mathematics do not

1. have predetermined objectives for student attainment.
2. possess a logical sequence in which the mathematics teacher/educator selected sequential learning activities for students.
3. emphasize a behavioural model of teaching Behaviourism stresses objective, measurable results in each step of student learning.
4. advocate paper-pencil tests to secure data on student achievement. Rather, the ability to define and solve real problems in mathematics provides evidence of learner achievement.
5. stress a highly structured sequence in the curriculum. Problem-solving emphasizes openness, creativity, and flexibility in problem identification, information gathering, hypothesizing, as well as testing and revising the hypothesis.

Information acquired and hypotheses testing might well provide for utilization of quality software.

Pertaining to problem-solving, Grossnickle, Reckzeh, Perry, and Ganoe[1] wrote the following:

Problem-solving is a process by which the choice of an appropriate strategy enables a pupil to proceed from what is given in a problem to its solution. Often the answer is the least important part of the problem-solving process; few of the answers children obtain in school mathematics will have much value in their lives. The ideas used in the process are much more valuable than the answer. Thus, it is important for teachers to determine whether an incorrect answer is due to an error in process or in computation. Do not, however, infer from this discussion that errors in computation are acceptable, rather, keep in mind that overemphasis on answers may impede the pupil's understanding of the process. A pupil with poor computational ability who understands the process can use a calculator to get the answer. A pupil who can compute rapidly and accurately but does not understand the process is lost.

A second philosophical school of thought in microcomputer/software use in mathematics is a decision-making strategy. With decision-making, the student selects learning activities from among alternatives. Thus in mathematics, an adequate number of software packages are available from which learners may select to pursue. A brief description of each is available to the learner. The student is the chooser and omits those not possessing purpose, meaning, and interest. In addition to software programmes, other avenues in learning are available such as textbook/workbook activities, as well as audio-visual experiences.

A learning centres approach may be utilized. Each centre contains relevant software related directly to the mathematics unit presently being taught. Content on the monitor for student interaction and acquisition of subject matter guides the learner to attain vital objectives. Diverse routes, including salient software, may be selected by the learner to attain objectives. To make choices means to choose from numerous software packages in order that objectives may be achieved A psychological mathematics curriculum is in evidence if each student sequences his/her routes (learning opportunities) to attain salient objectives. To emphasize increased decision-making, objectives to achieve may be chosen by the learner. A major goal here is that the student will select those objectives that are most challenging Optimal achievement for student attainment is of utmost importance in decision-making. Time on task in selecting and interacting with software content is a must. Through self selection, the student becomes actively involved in making choices in the mathematics curriculum. The learner is an active being rather than a passive recipient.

A contract system might also emphasize a decision-making strategy. Here the student with teacher guidance determines which computer programmes to complete. These are written up in contract form with the due date specified. Both the student and the teacher sign the agreed upon contract for learning activities to be completed by the former. The student then selects sequential programmes to complete.

To further stress decision-making strategies, students with teacher assistance may plan selected objectives of instruction in mathematics. To achieve the chosen objectives, students and the teacher cooperatively determine the learning opportunities, computer/software as well as other activities Appraisal procedures should also be cooperatively developed.

Decision-making strategies do not emphasize

1 a predetermined mathematics curriculum. Rather heavy input from learners is involved in selecting objectives, learning opportunities, and appraisal procedures within the framework of the mathematics software/computer curriculum.
2. a subject centered curriculum only. Attitudes and the affective dimensions are equally salient to emphasize as objectives of instruction in the mathematics curriculum involving computer/software utilization.
3. an essentialist or basics curriculum for all students. Rather choices and decisions, from among alternatives, may be made by learners in terms of activities and experiences in software programmes to pursue
4 a logical curriculum whereby the mathematics teacher or state-mandated objectives determine sequentially what students are to learn. Rather the learner in a psychological curriculum determines sequentially that which is to be learned.
5. a formal mathematics curriculum Instead flexibility and open-endedness are two viable concepts in that the student makes choices and decisions in the computer/software mathematics curriculum

Abelson[2] wrote the following on student control over computers/software:

> Logo is the name for a philosophy of education and for a continually evolving family of computer languages that aid its realization. Its learning environments articulate the principle that giving people personal control over powerful computational resources can enable them to establish intimate contact with profound ideas from science, from mathematics, and from the art of intellectual model building. Its computer languages are designed to transform computers into flexible tools to aid in learning, in playing, and in exploring.
>
> ... We try to make it possible for even young children to control the computer in self-directed ways, even at their very first exposure to Logo At the same time, we believe Logo should be a general purpose programming system of considerable power and wealth of

expression ... More than 10 years of experience at MIT and elsewhere have demonstrated that people across the whole range of "mathematical aptitude" enjoy using Logo to create original and sophisticated programmes. Logo has been successfully and productively used by preschool, elementary, junior high, senior high, and college students, and by their instructors.

A third philosophy of instruction to emphasize is measurement driven instruction (MDI). Measurement driven instruction stresses the utilization or predetermined objectives for student attainment. The objectives are stated in measurable terms prior to microcomputer/software use. Each end is precise. Either a student has/has not achieved the specific objective(s) after instruction. The objectives may be state-mandated, district wide instructional management systems, or written by the mathematics teacher.

To attain each objective, the student needs to experience quality software programmes. Each programme needs to align directly with the measurably stated objective(s). Subject matter contained in the software package then guides students to achieve the measurably stated objective(s). Content experienced by students must be sequential so that optimal learner progress is possible

Appraisal procedures must also align with the objectives so that content validity is in evidence. Reliability in measurement procedures is a must, be it test-retest, split-half, or alternate forms.

A carefully structured sequence of objectives, learning opportunities involving computer/software use, and appraisal procedures needs to be in evidence. Each component—objectives, learning opportunities, as well as appraisal procedures—is related to the other component. Thus, designing the curriculum with a measurement driven instruction model might guide students to achieve more optimally in the computer/software mathematics curriculum.

Measurement driven instruction does not emphasize

1 an open-ended mathematics curriculum whereby input from learners is in evidence pertaining to selecting software programmes.
2. a psychological sequence in which students are involved in sequencing their own experiences. Rather, mathematics educators select objectives, activities, and appraisal procedures in the hardware/software curriculum.
3. decision-making by students as to scope and sequence of the mathematics curriculum
4. problem-solving activities which relate society and school mathematics within the computer/software curriculum.
5. general objectives in mathematics. Instead, precise, measurably stated ends are emphasized in ongoing activities.

## In Closing

Software programmes in mathematics might emphasize

1 problem-solving strategies Real life problems in mathematics need identification and solutions.
2. students selecting from among alternative objectives and learning activities, as well as appraisal procedures.
3 measurement driven instruction. With precise predetermined objectives, students either do or do not achieve measurable ends as a result of learning activities.

The writer recommends continued emphasis be placed upon problem-solving. In the real world of society, individuals select and solve problems. Personal and social problems need solutions.

Software programmes in mathematics may emphasize:

1. drill and practice to have students review what has been learned previously.
2. tutorial to guide students to acquire new content in sequence.
3. simulations whereby students experience problem-solving in a role play situation.
4. games in which students individually or in a small committee compete against others in an atmosphere of respect and appreciation.

These four kinds of software packages should guide each student to achieve as optimally as possible in the mathematics curriculum.

Computer literacy in mathematics is important for all students. Pertaining to computer literacy, Flake, McClintock, and Turner[3] wrote:

Of all the uses of computers, which ones should all students learn to do comfortably and successfully? These questions have stimulated controversy among educators Some people equate computer literacy with the ability to select and use commercial software. Their argument is that the average person does not need to know how a computer works, what RAM is, or how to write a computer programme. They compare using a computer to driving a car—in order to drive, one does not need to know how a car works, what a manifold is, or how to do a tune-up.

On the other hand, some people equate computer literacy with knowledge of programming. Their argument is that in order for a person to use the computer to solve problems, that person needs to have the flexibility and control that a knowledge of programming provides. In short, knowledge is power.

## Selected References

1. Grossnickle, Foster E., John Reckzeh, Leland M. Perry, and Noreen S. Ganoe. *Discovering Meanings in Elementary School Mathematics* Seventh edition Chicago: Holt, Rinehart and Winston, 1983, page 177
2. Abelson, Harold. *Logo for the Apple II.* Peterborough, New Hampshire· BYTE/McGraw-Hill, 1982, page ix
3. Flake, Janice L., C. Edwin McClintock, and Sandra Turner *Fundamentals of Computer Education.* Second edition. Belmont, California· Wadsworth Publishing Company, 1990, page 297

# Improvement of Science Education in Schools: Indian Context

B. GANGULY
**Professor and Head,**
**Department of Education in Science and Mathematics**
**and Dean (Academic)**
**NCERT, New Delhi 110 016**

*It has now been recommended that while teaching science, technology must find a place in every child's experience. Link of science with the society is required for better learning and at the same time to develop understanding about the problems of the society The teaching-learning situations need to be selected from the environment of the pupil and worldwide concern about environment demands that science education must be linked with it*

## Introduction

Whenever we talk about "improvement", we mean to bring about some desired changes in the existing condition towards its betterment. If improvement of science education in our schools is our goal, then we must be fully aware of the existing conditions vis-a-vis science education in schools of our country Once these prevailing conditions are clearly understood, only then would it be possible to think about remedial measures. And to visualise the remedial measures, we must know the contemporary focus of science education. Finally on the basis of our past experience, we must also find the ways and means to make the remedial measures effective.

## Existing Status of Science Education as a Discipline

Science education as it is known today evolved along with education as a process. Application of findings of experimental psychology to education started from the early 19th century and continued up to the middle of 20th century. In the post world war II period, sociological ideas and methods joined the education. This enhanced the researches in education, which centred round three principal areas: 1) Social context of the educational institutions and students, 2) Nature of the teaching process and 3) Child's growth, specially intellectual development.

The findings of these research studies led to the coming of a number of textbooks on curriculum development and four "essentials" were identified for designing a curriculum (Tyler, 1950)

1. Determination of educational objectives representing the kind of behaviour that is to be developed in the student.
2. Decisions about the kind of learning experiences which might be relevant to the objectives, e.g. skills in thinking, acquiring knowledge, developing social attitudes and interest.

3. Organisation of experiences to provide continuity, sequence and integration within some general pattern.
4. Working out means of evaluation to assess the extent to which the objective had been achieved

In the early part of the 50s, development of science curriculum started as structured curriculum. On the basis of a theme, contemporary information was logically and sequentially presented as components. It was thought that this would help the child to construct a whole structure. Attempts were made to bring the school subject close to the higher level academic discipline and efforts were made to help the pupil to learn science like the scientists

This trend of science education gained momentum in the 60s, i.e., shortly after the launching of Sputnik. It began in the USA and gradually spread all over the world. Four reasons were responsible for the expansion of this trend:

1 Rise of educational expectations of students and their parents.
2. Coming of newer methods of teaching.
3. Coming of knowledge explosion, together with population explosion.
4. Occurrence of changes everywhere in the environment at a faster rate.

Several new features were seen in this curriculum development·

1 Subject experts, education experts, educational administrators and teachers joined together in the task of curriculum development.
2. Curriculum included a total package.
3. Curriculum development was supported by State or private funds.
4 There was a search of relevance—relationship with contemporary life and current state of knowledge.
5. The emphasis was on enquiry and discovery.
6. The emphasis was on the self-activity of the pupil.
7. Current innovations of teaching techniques specially teaching aids were used.

A change in the approach from teacher-oriented to child-centred curriculum was noted in the seventies. From the "product" of science, concentration was placed on the "process" of science. The emphasis on the discovery-learning by pupils on their respective programme brought flexibility in school education Instead of preparing the child for the present, attempts were shifted to the future, i.e., to a society that did not yet exist (Faure, 1972).

But soon it was felt that a balance of "product" and "process" is required Even in a child-centred curriculum, the teacher has to play the most important role. For this reason, from 80s, the focus was placed on strengthening of teacher education, so that the teacher not only becomes expert in transaction but also can develop and evaluate his/her own curriculum.

While coming close to the beginning of the 90s, it was found that no country was satisfied with its own school science curriculum. It was felt that too much emphasis on "process" diluted the knowledge of the "product" Rigour of science needs to be kept in mind to keep close to the advanced nature of science.

It has now been recommended that while teaching science, technology must find a place in every child's experience. Link of science with the society is required for better learning and at the same time to develop understanding about the problems of the society. The teaching-learning situations need to be selected from the environment of the pupil and worldwide concern about environment demands that science education must be linked with it.

## The Present State of Science Education in Indian Schools

No consolidated account on this is available, but we have a plethora of data collected through personal experience, findings of educational surveys and isolated reports. Let us try to list* them:

1. According to the Fifth All India Educational Survey (1986), in the first ten years of school, 12,47,05,810 students are studying science as a compulsory subject and nearly 34,18,925 teachers are teaching them in 7,20,306 schools.

   The discipline-wise higher secondary curriculum is taken up by nearly 43,100 students in 10,775 schools. At least one M.Sc. teacher is there in each school for each subject (What would be the picture in 2000 A.D.?).
2. Science has been introduced from the lowest level in all the States and UTs and it continues as a compulsory subject up to Class X (Is there any exception?).
3. Nationalised textbooks are followed up to Class V in all the States and UTs. From Class VI and above, several States continue to use textbooks developed by private publishers. (Is it true? Do we have a Statewise information?).
4. Up to the lower primary level (Class V) the syllabus is prepared by the Educational Directorates. Boards of Secondary Education do it for Classes VI to X, and Class XI and XII syllabuses are developed by Higher Secondary Council. (Is it the uniform picture in all States? What are the mechanisms followed by different States? How many States follow nationalised syllabus, i.e., NCERT syllabus?).
5. All States and UTs may either adapt or adopt materials developed by NCERT. Some States have taken up some materials. (Which are the States and UTs that follow NCERT material? How do they follow it?).
6. There are well defined national goals, educational goals, curriculum objectives and subject objectives. But textbooks are loaded with information, which is claimed to reflect the contemporary nature and rigour of the discipline (Is there any study analysing the textbooks to ascertain whether they fulfill the selected objectives?).
7. When the 10 plus 2 system was introduced, the two years of old Intermediate was transferred from college to the school. During implementation, this +2 stage was taken as the base for the higher studies and Classes IX and X were considered as the base for XI and XII. It was forgotten that Classes IX and X were the climax of general education and the total of ten years of general education was the base for XI and XII. For this reason, the students of Class IX and X had to go through the details of all subjects as if they were going to join the higher studies in all those subjects. (How far the science curriculum of Classes IX and X meets the objectives of science for all students?).
8. The constraints of transacting curriculum are well known. Some of these are: crowded classrooms, poor physical facilities (library and laboratories), poor training of teachers, overemphasis on examination, etc. While framing syllabuses and developing textbooks, these constraints are rarely taken into consideration. The result is that an apparently well-designed curriculum is often condemned as heavy or loaded. (Is there any study about the curriculum load? Has there been any effort to suggest alternate transaction mechanism to overcome the constraints?).

---

* The reader is welcome to add more points to this list.

9. The language of the science textbooks (English, Hindi and Regional languages) is often more difficult than the language textbooks of the same class. (Is it true? Is there any study? There are innumerable studies in other countries about reading ability—Do we have similar studies in our country?).
10. Textbooks are overburdened with facts, figures and data. In order to minimise the volume of the textbooks, clarity has often been sacrificed for brevity. (Earlier, NCERT had developed guidelines for writing textbooks. How far NCERT has followed these guidelines in its own textbooks? Is there any study showing comparative evaluation of textbooks followed in different States?).
11. In most schools, the textbook is the only source for teaching learning of science. Teachers' contact with the world of science is also only through the textbook. In most places, the teaching is completely based on page by page reading of the textbook. (Is there any study about the extent of dependence on textbook by the teachers and students?).
12. Teaching is restricted to lecture-cum-demonstration, followed by verification type of laboratory experiments. Teachers seldom use other teaching methods which they have learnt in the pre- and in-service training programmes. Excepting blackboard, charts and models, other teaching aids are rarely used. (Is it true? If yes, then to what extent? What is the utility of the teacher's guide? Is there any study about the transaction problem?).
13. Most schools do not have laboratories up to secondary stage. Equipment is limited and insufficient. Libraries do not have sufficient number of books. In some schools, kits are provided, but are rarely used. (Is there any study regarding the use of laboratories and libraries in the teaching of science?).
14. Students have different ways of learning. In a crowded classroom, with mixed ability groups, the teacher is not able to meet the learning requirements of the individual student. (Is there any study regarding the use of alternate mode of teaching in the present condition?).
15. As the lecture method is good enough for rote learning, which is the only requirement of the present examination system, neither the teacher nor the students feel any need to learn science for attaining the fulfillment of its pre-determined objectives. (Do we have detailed information about the transaction in the science classrooms of our country?).
16. A small proportion of students are encouraged to take advantages of national talent examination, State/national level science exhibition, olympiads, etc. It is, therefore, extremely difficult to identify and nurture creative and talented students. (Is there any study about identifying and nurturing gifted students in our country?).
17. Evaluation basically has remained subjective (in spite of using the format of the objective type questions) and attempts only to test the memorisation and rote-learning ability. Nothing is practically done to test the fulfillment of other predetermined objectives. (Is there any study on testing affective domain objectives in our country?).

### What is to be Done to Improve Science Education?

Well, even if we cannot define the problems in empirical terms, it is evident that they are enormously diverse in nature and stupendous in magnitude. Naturally, there is no single, one stroke solution. A comprehensive approach therefore, is necessary encompassing all areas o our activities. Actions are required in the area of:

A. *Research*· Education today is based on the combination of discipline (i.e., subject), experimental psychology and sociology We are trying to improve science education from the sixties i.e., almost simultaneously with USA and UK, but our materials have remained only discipline oriented. We need research-based information on all the three areas: 1) Social context for educational institutions 2) Nature of the teaching process and 3) Child's physical growth specially intellectual development.

B *Development.* Development should be based on research findings In the absence of that we shall never be along the prescribed lines of curriculum development (Tyler, 1950). A review of the work done in the development of national level material indicates that up to the development of syllabus, we were on the right track. But always a defective mechanism crept into the process of development of textbooks. It happened repeatedly and for this reason our textbooks of several generations are in the similar state. Innovations attempted at lower primary (Environmental Studies), upper primary (Learning Science) and secondary (Science) could not be tested and improved properly

C. *Training:* Researches are required also to enrich teaching process. Training must equip a teacher to design his/her own teaching plan on the basis of the enrichment and learning ability of the child. Ability to go for alternate strategy to create teaching learning situation and ability for necessary innovation and improvisation must develop in a teacher. The pupils learn only through information obtained through all the five sense organs. The duty of the teacher is to present the information properly so that in the mind of the pupil it is transformed into knowledge, develops awareness and brings a sense of participation.

D. *Extension:* The demand from the community has always been a great force which influenced the science curriculum. In our country this demand is only for examination result. More extension activities are needed to create demand in the community for right type of science education. It is possible to create interest in science in all types of environment. The different activities undertaken towards the popularisation of science have shown positive results. But we are to go a long way towards the development of scientific literacy. Our efforts to take science to all students must be extended to all the members of the community

While planning all those activities mentioned above, it would be important to remember that:

1. Education must be democratized Equal opportunity of education must be available to all children irrespective of manifold differences between them Beyond the right to "enrolment", every child must have appropriate "transaction" facilities for learning.
2. Total planning of education is necessary. The existing patchy efforts to improve here and there should be replaced by a total plan from primary to higher education.
3. Qualitative improvement must not be lost sight of while striving for quantitative improvement.

## Suggested Reading

Science Education today is a discipline which is rapidly growing and changing through research and innovations. A number of magazines, journals and periodicals are published today from different countries on science education. Even daily newspapers are coming out with supplements on education, where science education occupies significant space. Names of a few books and papers are mentioned below, which definitely is not as extensive as it should be. The names of most of the well-known UNESCO publications like "New Trends" series have been omitted here but should not be excluded by the students of science education. Science Education Newsletter of the British Council, Commonwealth Secretariat and magazines like *New Scientist*, *American Scientist* and *Times Educational Supplement* are extremely useful. The educational supplement of Hindu and UGC sponsored journals of Physics, Chemistry and Biology Education are quite thought provoking. The materials which may be useful to the persons interested in science education but not directly associated with it is marked *.

1. Basset, G.W. *Innovation in Primary Education*. Wiley, London, 1972.
2.* Bernal, J.D. *Social Function of Science*. Cambridge MIT Press, 1967 (1st published in 1939).
3 Bloom, B.J. *Stability and Change in Human Characteristics*. Wiley, New York, 1964
4. Bloom, B.S (ed ) *Taxonomy of Educational Objectives* Longman Green, New York, 1956.
5.* Bremer, J. and M von Moschzisker. *The School Without Walls* Holt, Rinchart and Winston, New York, 1971.
6. B.S.C S. *Co-operative Learning in the Classroom*. The Natural Selection, Colarado Springs, USA, 1989.
7 Commonwealth Secretariat. *Interrelating Science and Mathematics and Technological Education · A Case for General Education for All*. London, UK, 1982.
8.* Connell, W F. *A History of Education in the 20th Century World*. Curriculum Development Centre, Canberra, Australia, 1980.
9.* Cros, L. *The Explosion in the Schools*. Sevres, Paris, 1963.
10. Damiba, A. *Education in Africa in the Light of the Lagos Conference*. UNESCO, Paris, 1977.
11.* Department of Education and Science, Great Britain. *Children and their Primary Schools (Vol. 1)*. Plowden Report, HMSO, London, 1967.
12.* Department of Education, MHRD. *National Policy on Education* Government of India, 1986.
13.* Dewey, J. *Democracy and Education*. Macmillan, New York, 1916.
14.* Faure, E. *Learning to Be*. UNESCO, Paris, 1972.
15.* Gandhi, M.K "Basic Education". *Harijan*, September 1937.
16 * Gandhi, M.K. *Towards New Education*. (Ed B. Kumarappa). Navjivan Publishing House, Ahmedabad, 1953.
17 Ganguly, B "Development of Science Education", *School Science*, NCERT, New Delhi, 1975.
18 — "From Biology to Life Science: Impact of the Changes on Biology Education", *J Indian Education*, NCERT, New Delhi, 1970.
19 — "Science Education for Changing World", *School Science*, NCERT, New Delhi, 1978.
20. — "Impact of Science Education on Everyday Life Situations". Symposium on World Trends in Science and Technology Education, Kiel, 1987.
21 — "Science in General Education", CENBOSEC, Central Board of Secondary Education, New Delhi, 1988.
22. — "Looking for a Better Education", *The Radical Humanist*, **54** (7), October, Delhi, 1990.

23.* — "Science Education at the Turn of the Century: Objectives and Strategies". *Report of the XIIth Indian Social Science Congress*, Mysore, 1987.

24. — "Current State of Science Education at the School Level". *Report of the Seminar on Science and Technology*, Punjabi University, Patiala, Punjab, 1987.

25.* Grant, N. *Soviet Education.* Penguin, Harmondsworth, UK, 1964.

26.* Harcleroad, F.F. (ed.). *Issues of the Seventies.* Jossey-Bass, San Francisco, USA, 1970.

27. Hartog, P. *Some Aspects of Indian Education—Past and Present.* Oxford University Press, 1939.

28.* Hindustani Talimi Sangha. *Educational Reconstruction.* 5th ed. Wardha, 1950.

29. Hodson, D. "Towards a Philosophically More Valid Science Curriculum", *Science Education*, 72 (9), 1986.

30.* Kothari, D.S. *Education, Science and National Development.* Asia, London, 1970.

31.* Karve, D.G. and D.V. Ambekar (ed.). *Speeches and Writings of Gopal Krishna Gokhale.* Asia, London, 1967.

32. Levell, K. *The Growth of Basic Mathematics and Scientific Concepts in Children.* University of London, 1966.

33.* MacFarquhar, R. *The Hundred Flowers Campaign and the Chinese Intellectuals.* Praegar, New York, 1960.

34.* Mao Tsetung. "Scientific and Technological Training". *Peking Review*, July, 1968.

35. Meisale, V. and H. Kuitune (ed.) *Innovations in the Science and Technology Education.* The Finish National Board of General Education, Helsinki, 1990.

36.* Ministry of Education. *Education and National Development*, Report of the Education Commission (Kothari). 1964-66, New Delhi, 1966.

37. — *Report of the University Education Commission (Radhakrishnan).* New Delhi, 1949.

38.* — *Report of the Secondary Education Commission (Mudaliar).* New Delhi, 1953.

39.* — *Basic Education in India* (Ramachandran Committee's Report). New Delhi, 1956.

40.* Mukherjee, K.C. "The Classroom in India. The Pressures of Population and Poverty". *Aspects of Education*, 14, 1972.

41.* Nagappa, R.R. "The New Outlook that is Much Needed". *Indian Journal of Adult Education*, July, 1975.

42. NCERT. *Science and Mathematics Education in Indian Schools.* Report of UNESCO Planning Mission, New Delhi, 1964.

43. — *Implementation of Science Education Programme.* Report of the Workshop held in the Department of Education in Science and Mathematics, NCERT, New Delhi, 1986.

44. — *Educational Television for Children of the Developing World.* Report of the Workshop in CIET, New Delhi, 1986.

45. — *Studies in the Area of Adopting Science and Technological Education to Changing Society.* Delhi, 1982.

46. — *Science Education for the First Ten Years of Schooling.* Report of the Working Group, New Delhi, 1987.

47.* — *National Curriculum for Elementary and Secondary Education: A Framework.* Revised Version, New Delhi, 1988.

48. National Science Board. *Educating American for the 21st Century: A Plan of Action.* Report of the Commission on Pre-College Education in Mathematics, Science and Technology, Washington, USA, 1985.

49. NIER. *Some Critical Aspects of Secondary Education in the Countries of Asia and Pacific.* Section for Educational Co-operation in Asia, NIER, Tokyo, Japan, 1988.

50.* Nurullah, S. and J.P. Naik. *A History of Education in India.* Macmillan, Bombay, 2nd ed. 1951.

51. OECD. *Policies for Higher Education.* OECD, Paris, 1974.

52.* Reeves, M. (ed.) *The Problem of 18 Plus.* Faber & Faber, London, 1965.

53. Rosenshine, B. *Teaching Behaviour and Student Achievement.* NFER, Slough, 1971.

54.* Saiyidain, K G. *The Humanist Tradition in Indian Education Thought.* Asia Publishing House, London, 1966.

55. Smith, R.W. *Technological and Social Change, the Future and Education—A Broader Perspective.* Report of UNESCO Regional Seminar on the Evaluation of programme for Computer Education in Australia, 1987.

56.* Snow, C.P. *The Two Cultures and the Scientific Revolution.* Cambridge University Press, 1959.

57.* — *Two Cultures and a Second Book*—An expanded version of the *Two Cultures and the Scientific Revolution*, Cambridge University Press, UK, 1965.

58.* Siberman, C.E. *Crisis in the Classroom.* Prentice Hall, New York, 1971.

59.* Spender, S. *The Year of the Young Rebels.* Vintage, New York, 1968.

60. Standing, E.M. *Maria Montessori, Her Life and Work.* Mentor-Omega, New York, 1962.

61.* Suehomlinski, V.A. *On Education.* Politizdat, Moscow, 1973.

62.* Taba, H. *Curriculum Development—Theory and Practice.* Harcourt, Brace and World, New York, 1962.

63. Tyler, R.W. *Basic Principles of Curriculum and Instruction.* University of Chicago, 1950.

64. UNESCO. *Educational Planning—A Survey of Problems and Prospects.* Paris, 1968.

65. — *Conference on Education and Scientific and Technical Training in Relation to Development in Africa, Nairobi.* July, 1968.

66. — *New Techniques for Preparing Educational Personnel.* Bangkok, 1980.

67. — *New Trends in School Science Equipment.* Paris, 1983.

68. — *Training of Personnel for Distance Education: Report.* Bangkok, 1984.

69. — *International Conference on Education, 40th Session; Final Report.* International Bureau of Education, Geneva, 1986.

70. — *Science and Technology in School Curriculum—Case Study 4.* India, Paris, 1988.

71.* **Wiseman, S.** ***Education and Environment.*** Manchester University Press, UK, 1964.

72.* *Yojana, Education Special.* Volume 30, Nos. 1 and 2, 1986.

# Identification of Misconceptions Related to Work and Energy Among Students

A.B. SAXENA
**Regional College of Education**
**Bhopal 462 013**

*Physics learning by the students could be more effective if students are able to link 'symbolic world' of physics with their 'life world' of experience outside classroom*

Many studies have been conducted in the recent past related to energy. Some are enthrographical in nature (Watts, 1983, Watts and Gilbert, 1983; Duit, 1983) and provide the conceptual map of students about energy. The other category of studies deals with teaching of energy, its conservation and other related aspects (Black and Solomon, 1985; Driver and Warrington, 1985; Urevbu, 1984). On the basis of students' thought on different aspects of energy, Brook and Driver (1984) suggested a teaching strategy for developing students' concept of energy. Duit and Orpaz (1983) suggested a five-stage programme for teaching 'energy' in the schools. In comparison, there are fewer studies on 'work' (Archenhold, 1982; Saxena, 1989b). The present work is a part of a comprehensive study to identify misconceptions among physics students related to basic concepts in physics. Misconceptions related to 'motion' have been reported separately (Saxena, 1989a). Both these studies are conducted at senior secondary (Standard XII) and at undergraduate levels.

## Plan of Study

In this study, the technique used is similar to the one used earlier (Saxena, 1989a). The unit 'Work and Energy' was conceptually analysed Table 1 provides the major concepts and their interrelationship to this unit that were taken up in this study. On this basis, a questionnaire (Appendix 1) was developed consisting of eleven situational questions. Each question has three/four possible answers and students were required to choose one The students were also asked to write down the possible reason for choosing a particular response. The reasons given by students were

**TABLE 1**
**Conceptual Framework of Unit 'Work and Energy'**

| Basic elements | Important related concepts |
|---|---|
| Energy | Conversion from one form to another<br>Conservation<br>Relationship with work |
| Work | Relation with force<br>Calculation of work<br>— in gravitational field<br>— stretching an elastic body |

later analysed as these provided the basis for identification of the misconceptions. The arguments given in favour of right response were also included in the analysis for they helped in the identification of misconceptions.

The concepts included in this study are related to Standard X and are fundamental to the understanding of physics. The study was conducted at different levels of education including senior secondary Standard XII and undergraduate. The students were in six groups, and their details are given in Table 2. The students came from different parts of two states, Madhya Pradesh and Orissa. No selection was made for the purpose of the study. All the students who were attending the respective courses were administered the questionnaire. The student population consisted of both boys and girls. However, sex was ignored in

**TABLE 2**

| *Group* | *City* | *Level* | *No of students* |
|---|---|---|---|
| Group 1 | Bhopal | XII | 94 |
| Group 2 | Amla | XII | 14 |
| Group 3 | Bhopal | B.Sc./B.Ed. I* | 26 |
| Group 4 | Bhubaneswar | B.Sc.(Pass)/B.Ed. I* | 31 |
| Group 5 | Bhubaneswar | B.Sc.(Hons)/B.Ed. I* | 13 |
| Group 6 | Bhubaneswar | B.Sc.(Hons)/B.Ed. II* | 13 |

* These are four-year integrated courses of science and education at undergraduate level.

**TABLE 3**
**Percentage of Right Responses**

| *RR (RR with CA)* | *Group 1* | *Group 2* | *Group 3* | *Group 4* | *Group 5* | *Group 6* |
|---|---|---|---|---|---|---|
| Question 1 | 37.2 | 71.4 | 57.7 | 64.5 | 76.9 | 92.3 |
| Question 2 | 51.1 | 64.3 | 38.5 | 58.1 | 76.9 | 76.9 |
| Question 3 | 45.7 | 50.0 | 50.0 | 67.7 | 46.2 | 53.9 |
| Question 4 | 14.9 | 35.7 | 53.9 | 32.3 | 53.9 | 53.9 |
| Question 5 | 14.9 | 14.3 | 19.2 | 22.6 | 30.8 | 15.4 |
| Question 6 | 76.6 | 92.9 | 80.8 | 71.0 | 53.9 | 69.2 |
| Question 7 | 25.5 | 35.7 | 15.4 | 25.8 | 38.5 | 23.1 |
| Question 8 | 36.2 | 42.9 | 61.5 | 19.4 | 53.9 | 23.1 |
| Question 9 | 22.2 | 42.9 | 15.4 | 32.3 | 53.8 | 53.8 |
| Question 10 | 27.7 | 28.6 | 38.5 | 9.7 | 53.8 | 30.8 |
| Question 11 | 46.8 | 42.9 | 26.9 | 48.4 | 69.2 | 92.3 |

**TABLE 4**
**Percentage of Correct Arguments**

| | *Group 1* | *Group 2* | *Group 3* | *Group 4* | *Group 5* | *Group 6* |
|---|---|---|---|---|---|---|
| Question 1 | 7.5 | 7.5 | 3.8 | 9.7 | 7.6 | 15.4 |
| Question 2 | 20.2 | 50.0 | 19.2 | 22.6 | 30.7 | 53.9 |
| Question 3 | 24.5 | 42.9 | 26.9 | 38.7 | 23.1 | 38.5 |
| Question 4 | 8.5 | 28.6 | 30.7 | 25.8 | 53.9 | 53.9 |
| Question 5 | 2.1 | 7.1 | 0.0 | 6.5 | 0.0 | 7.7 |
| Question 6 | 31.9 | 71.4 | 57.7 | 48.4 | 53.9 | 46.2 |
| Question 7 | 6.4 | 7.1 | 3.9 | 9.7 | 38.5 | 7.7 |
| Question 8 | 22.3 | 21.4 | 34.6 | 9.7 | 23.1 | 23.1 |
| Question 9 | 12.8 | 35.7 | 0.0 | 9.7 | 30.8 | 38.5 |
| Question 10 | 13.8 | 7.1 | 7.7 | 6.5 | 30.8 | 7.7 |
| Question 11 | 20.2 | 21.4 | 15.4 | 16.1 | 38.5 | 76.9 |

the analysis of the responses. Sufficient time was given to students to answer all the questions. A period of forty five minutes was found to be sufficient for this purpose.

## Analysis of Responses

Table 3 shows the percentage of right responses (RR) obtained for each question. Table 4 shows the percentage of students who were able to provide correct argument (CA) in support of the correct choice made by them. As observed earlier (Saxena, 1989a) a comparison of Tables 3 and 4 shows that a large fraction of students are able to choose the right response but are not able to support it by correct argument. This shows superficial learning of concepts. Moreover, the percentage of students that is able to choose the right response is not encouraging in many cases, and related misconceptions need to be attended to. After these general comments, the responses to each individual question are discussed in detail.

### *Question 1*

This question cites a simple situation that is observed in everyday life. Although a large percentage of students is able to choose the right response (Table 4), yet most of them are not able to explain the phenomenon. However the statements like,

> "from the law of conservation of energy, energy is neither created nor destroyed"

have not been considered as correct argument, for these do not show the deeper understanding of conservation of energy in the process. Table 5 shows the percentage of students who explicitly state that energy is destroyed because the body comes to rest. The statements claiming this are such as:

> "after coming to rest, its velocity becomes zero, hence kinetic energy is zero".
>
> "when body comes to rest, its velocity becomes zero, so the kinetic energy is completely destroyed".

**TABLE 5**

| | *Group 1* | *Group 2* | *Group3* | *Group4* | *Group5* | *Group 6* |
|---|---|---|---|---|---|---|
| Completely destroyed because velocity zero | 14.9 | 21.4 | 19.2 | 9.7 | 7.7 | 7.7 |
| Partly destroyed | 36.1 | 7.5 | 19.2 | 16.1 | 15.4 | 0.0 |

At the same time, many students think that the energy is partly destroyed:

> "energy cannot be destroyed but due to some type of friction little part of energy is destroyed and other part is converted into other forms like heat energy"

> "because due to friction some energy is destroyed and some is converted into other forms".

This shows that many students think that energy is destroyed due to friction and/or energy depends on observable characteristic (velocity).

*Question 2*

Although in all the groups, except group 3 majority of students are able to choose the right response, many are not able to give the proper explanation for it. However, it is difficult to give its reason, because most of such students have not written any reason in this case

The most common wrong response is "potential energy of the arrow is converted into kinetic energy". The percentage of such students in different groups is 22.3, 21.4, 19.23, 12.9, 23.1 and 15.4 respectively. Its explanation comes in this form:

> "at first potential energy is maximum and kinetic energy is zero, but when (arrow) left the former becomes zero and is converted to kinetic energy"

It has reminiscence of "conversion of potential energy of a falling body into kinetic energy".

*Question 3*

In this case, about half of the students are able to choose the right response. However, many students 44.7, 28.6, 15.4, 25.8, 15.4, 38.5, per cent respectively think that state 1 has higher energy. Many students argue that state 1 is more compact/compressed hence it has more energy:

> "because there is 'close' winding in state 1"

> "internal energy is always more when the molecules are close to each other"

The other common reason for this is like the following.

> "because in the state 2 some energy is lost due to stretching".

In some other cases, students think that in stretching the spring does the work, therefore 'state 2' has less energy than 'state 1'. Apart from this, some students think that energy remains the same in both the states "as stretching has no effect on the energy of the spring".

*Question 4*

This question requires simple calculation using $W = Fd\cos\theta$. The analysis of the responses shows that a large percentage of students forget 'cos θ' factor and hence arrive at response '100'. The percentage of such students in various groups is 70.2, 64.3, 34.6, 61.3, 30.8, 28.5 respectively, out of which 53.2, 42.8, 26.9, 51.6, 30.8 and 28.5 per cent students (of the total) write the formula $W = Fd$. This is perhaps due to wrong introduction of the mathematical concept of work as the product of force and displacement. (Balasubramanian et al., 1988; White, 1987). Once a concept is formed, it is difficult to modify it (Driver and Erickson, 1983).

### *Question 5*

In circular motion the centripetal force and displacement are always mutually at right angle. It is for this reason that work done in any part of the revolution is zero. Many students do not realise this. It is reflected in the percentage of students who give the right response. Table 6 provides percentage of the two incorrect responses. A large percentage of students calculates the work done as the product of force and displacement. If they take centripetal force $mv^2/r$ as the force they arrive at response (i) and if they take weight mg as the force (though erroneously) they arrive at response (ii). These results support the conclusion drawn with reference to question 4.

### *Question 6*

This question also requires the calculation of work done. Sometimes it is suggested that students should also be presented with problems where they have to decide what relevant information is (Driver and Warrington, 1985). This question and question 7 contain some extra information and students have to choose the appropriate information. We have found that many students have been misled due to this extra information. Table 7 shows the percentage of students who think that Ram does more work. It also shows the percentage of students who explicitly state that this is due to shorter duration in which he is able to complete the work. It appears that students are not able to differentiate between power—rate of doing work—and total work done.

### *Question 7*

Apart from selection of the relevant information this question requires the use of conservation of energy. Driver and Warrington (1985) have reported that students tend to interpret in terms of observable characteristics such as force, displacement rather than principle of conservation of energy. In this question our experience is also

**TABLE 6**

| *Percentage of students* | *Group 1* | *Group 2* | *Group 3* | *Group 4* | *Group 5* | *Group 6* |
|---|---|---|---|---|---|---|
| $\frac{mv^2}{r}\cdot\pi r$ | 45.7 | 78.6 | 38.5 | 51.6 | 61.5 | 76.9 |
| $mg\cdot\pi r$ | 27.7 | 0.0 | 15.4 | 6.5 | 7.6 | 7.6 |
| Work = Force × distance (in response i and ii) | 23.4 | 35.7 | 30.7 | 32.3 | 53.8 | 76.8 |

**TABLE 7**

| *Percentage of students* | *Group 1* | *Group 2* | *Group 3* | *Group 4* | *Group 5* | *Group 6* |
|---|---|---|---|---|---|---|
| Ram | 25.5 | 7.1 | 15.4 | 22.6 | 46.2 | 30.8 |
| Due to less time | 18.1 | 7.1 | 11.5 | 12.9 | 7.7 | 23.1 |

TABLE 8

| *Percentage* | *Group 1* | *Group 2* | *Group 3* | *Group 4* | *Group 5* | *Group 6* |
|---|---|---|---|---|---|---|
| Same temperature | 48.9 | 50.0 | 30 8 | 64.5 | 38.5 | 61.5 |
| Same temperature as thermos is insulated | 29.8 | 50.0 | 23.1 | 64.5 | 30.8 | 61.5 |

similar. Very few students are able to give the correct response and provide the right argument for it. In every case except one (group 5) the percentage of such students is less than 10 (Table 4). Most commonly it is found that students calculate the work done by multiplying weight by the distance moved, which is in terms of, though wrongly, observable variables.

*Question 8*

The concept of temperature is elusive to the students and they are not able to correlate this with molecular energy For this reason, presumably, a large fraction of students think that temperature of the thermos will remain the same (Table 8). Out of these most of them explicitly state that this is because the thermos is insulted. This is reflected in statements such as:

> "we know that there is no change in temperature inside the thermos".
>
> "because neither the heat goes outside nor comes inside".

Only a few students give a clear explanation as

> "the kinetic energy of molecules increases resulting in increase in heat inside the thermos flask".

*Question 9*

Like question 1, question 9 also judges the concept of conservation of energy. In this case the most prominent response is conversion to potential energy. The percentage of students stating this in various groups is 48.9, 25.7, 46.2, 38.7, 38.5, and 38.5. It appears students use the term potential energy without understanding its meaning (McDermott, 1984). The analysis of responses for question 1 becomes relevant in this context. Some students also state that energy is completely destroyed because the ball finally comes to rest. This remark is similar to the argument that the energy is destroyed because body comes to rest (question 1).

*Question 10*

Pendulum and its motion is familiar to the students of science. Yet very few students give the correct response in this case (Table 3) and still fewer are able to explain this on the basis of conservation of energy. This is in agreement with the observations made with regard to question 7. Many students presume that point C is the correct response because it is on the farthest side to the right and compare this with their observation of a pendulum.

*Question 11*

The concept of energy with the observable quantity velocity is again reflected in this case. Though a large percentage of students choose the correct response (Table 3) yet in most of the groups about half of them (Table 4) are able to justify it scientifically. The reflection of 'velocity' is observed in the fact that 30.9, 50.0, 53.9, 12.9, 23.0 and 7.7 per cent students respectively feel that the toy car has maximum velocity when it is in motion. About fifty per cent of these explicitly state that this is due to velocity of the car:

> "because the car will have more velocity hence maximum energy"
>
> "the energy of the car is due to its motion".

Brook and Driver (1984) observed that one in ten students state the dependence of energy on velocity. Only few students give statement like this:

> "since the completely wound spring provides the sufficient kinetic energy to the car so as to move".

### Discussion

Analyses of different kinds of responses and arguments given in their favour give us an idea of the possible misconceptions that could exist among students, who had more than eleven years of schooling. At the same time, it is also realized that these misconceptions have different frequencies, depending upon the socio-cultural background of the students. Despite this some common misconceptions could be identified which occur with varying frequencies in different populations. These possible misconceptions are as under

1. Energy of a body is destroyed completely or partly when it comes to rest This could be due to friction.
2. When a body moves, its motion is due to change of its potential energy to kinetic energy.
3. A body in compact form has higher energy.
4. Work done by a force is the product of force and displacement, irrespective of the angle between them.
5. Work done depends on how fast it is done.
6. Temperature is the inherent characteristic property of the substance, it does not change by working on it.
7. A moving body has more energy than when it is at rest. Apart from these misconceptions, it is also observed that observational properties influence the students to draw the conclusion, rather than the abstract principles.

### Implications

There are many words like work, power, energy which have different meaning in everyday observation and in physics. Black and Solomon (1985) group these two different meanings related to 'life world' and 'symbolic world'. The former meaning is related to and is reinforced by our life experiences. The latter meaning is related to physics/science and is confined to its scope only. Accordingly, physics learning by the students could be more effective if students are able to link 'symbolic world' of physics with their 'life world' of experience outside classroom.

This does not imply replacement (Brook and Driver, 1981) of the meaning in the context of life world by the meanings in the context of science but help the students to modify the conceptual framework such that they are able to choose the appropriate meaning according to context.

The results reported here are similar to another study (Saxena, 1989b) conducted on teachers. This would imply that a more careful planning will be required to deal with the concepts of work and energy. This programme would include the training of teachers to help them clarify their concepts and modify these to make them scientifically acceptable.

## References

1. Archenhold, F. "An Empirical Study of the Understanding by 16-19 Year-old Students of the Concepts of Work and Potential in Physics". In *Cognitive Development Research in Science and Mathematics*, 1982, Archenhold W.F. et al. (eds.), University of Leeds, Leeds.
2. Balasubramanian, D. et al. 1988. *Science. A Textbook for Class IX*, National Council of Educational Research and Training, New Delhi.
3 Black, P and Solomon, J. 1985, "Life World and Science World· Pupils' Ideas about Energy". In Hodgson, B. and Scanlon, E. (eds.) 1985, *Approaching Primary Science*. Harper Education Series.
4. Brook, A. and Driver, R. 1984, "Aspects of Secondary Students Understanding of Energy". *Summary Report, Children's Learning in Science Project*, University of Leeds.
5. Driver, R. and Warrington, L. 1985, "Students Use of the Principle of Energy Conservation in Problem Situations", *Phys Ed.*, 20 (4), 171-76
6. Duit, R. 1984, "Learning the Energy Concept in School Empirical Results from the Phillipines and West Germany", *Phys Ed* , 19 (2), 59-66.
7 Duit, R and Orpaz, N. 1983, *Energy in Physics Education for Later Citizens*. (Preliminary draft).
8. McDermott, L.C. 1984, "Research on Conceptual Understanding in Mechanics", *Phys. Today*, 37, 24-32.
9. Saxena, A.B. 1989a, "Identification of Misconceptions Related to Motion Among Indian Students". (Unpublished, communicated).
10. Saxena, A B. 1989b, "Teacher Concept of Work and Energy". (Unpublished, communicated)
11. Watts, D.M. 1983, "Some Alternative Views of Energy", *Physics*, **18**, 213-17.
12 White, H.E. 1987, *Modern College Physics*. (Indian edition of original published by Litton Educational Publishing, Inc.). CBS Publishers and Distributors, New Delhi.

# Appendix 1

Name: ______________________________

Instructions: 1. Tick (✓) the most suitable answer.

2. Explain the reason for making the choice.

(Right responses are marked with asterisk *)

1. A body falling with velocity 2 m/s comes to rest after striking the ground. What happens to its kinetic energy?
   i) It is completely destroyed.
   ii) It is partly destroyed and partly converted into other forms.
   iii)* It is completely converted into various forms.
   iv) (any other).
   Reason ___________________________

2. An arrow is thrown by a bow with velocity 3 m/s. What is the source of its kinetic energy?
   - i) The potential energy of arrow.
   - ii)* The potential energy of compressed bow.
   - iii) Gravity.
   - iv) Reaction to the pressing of the air.

   Reason ________________________

3. Figure 1 shows a spring in two states. State 1 shows normal state of the spring and state 2 shows its stretched state. Which statement is true about its energy?
   - i) The energy in both states is the same.
   - ii) The energy in state 1 is more.
   - iii)* The energy in state 2 is more

   Reason ________________________

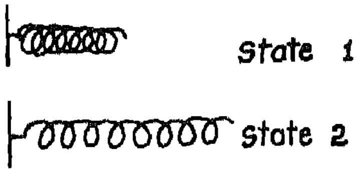


Fig. 1

4. A force of 20 newton is applied along a rod *AB* to displace a stone of mass 2 kg by 5 m in horizontal plane (Fig. 2). What is the work done, if the surface is frictionless?
   - i) 10 g Joule.
   - ii) 100 Joule.
   - iii)* 50 Joule.

   Reason ________________________

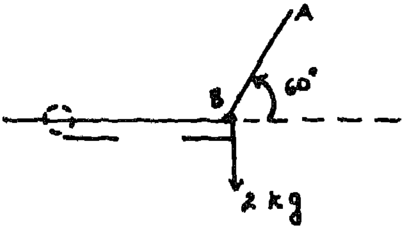


Fig. 2

5. A satellite is revolving round the earth with constant speed $v$ (Fig. 3). What is the net work done in half revolution?
   - i) $\frac{mv^2}{r}\cdot\pi r$
   - ii) $mg\cdot\pi r$
   - iii)* zero.

   Reason ________________________

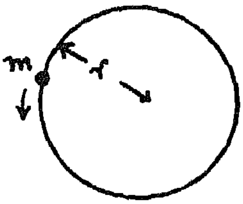


Fig. 3

6. A heavy stone of mass *M* is lifted and kept on the raised platform. Ram does this in 5 seconds and Shyam does this in 10 seconds. Neglecting air friction, which statement is true?
   - i) Ram does more work.
   - ii) Shyam does more work.
   - iii)* Ram and Shyam do equal work.

   Reason ________________________

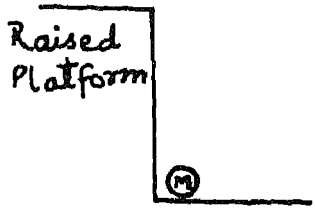


Fig. 4

7. A ball with velocity 10 m/s and mass 0.2 kg penetrates the sand and comes to rest after travelling 5 cm in the sand. What is the work done by the sand. (Neglect temperature changes).
   i) Zero.
   ii) 50 Joule.
   iii) .098 Joule.
   iv)* 10 Joule.
   Reason ____________________

8. A sealed and perfectly insulated thermos with coffee inside is shaken vigorously. What will happen to the temperature of the coffee?
   i)* Rise.
   ii) Fall.
   iii) Remain same.
   Reason ____________________

9. A ball rolling on a horizontal floor stops after moving some distance Which statement is true about its kinetic energy?
   i) It is converted into potential energy of the ball
   ii) It is completely destroyed.
   iii)* It is converted into heat and other forms of energy.
   iv) It is partly destroyed and partly converted into other forms of energy.
   Reason ____________________

10. A bob hanging as simple pendulum is taken to position *P* (Fig. 5) and released (no force applied to the bob while releasing). Up to which position is it most likely to go? (Neglect air friction).
   i) *A*
   ii)* *B*
   iii) *C*
   Reason ____________________

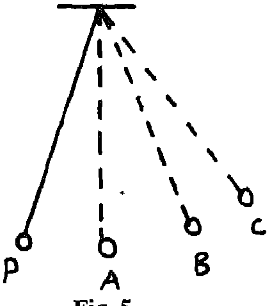


**Fig. 5**

11. †There is a toy car with winding spring. A boy winds the spring completely and lets the car go. The car moves a certain distance and stops. When had the car maximum energy?
   i) Before winding.
   ii)* When the spring was completely wound.
   iii) When the car was in motion.
   iv) When the car finally stopped.
   Reason ____________________

---

† Based on Brook and Driver (1984).

# Cognitive Preferences in Operation: An Example

JYOTI PRAKASH BAGCHI
**Lecturer**
**Department of Teacher Education**
**D.S. College, Aligarh 202 001**

*A teacher taking up a unit for discussion in the classroom reflects his teaching preference during the course of his teaching Instead of stating only cold and dry facts and rigid theories, classroom milieu may be made alive and dynamic by presenting factual scientific information in its varied connotations This is certainly not to suggest that teaching depends only upon individual idiosyncracy, and teacher will teach certain things and leave others simply because he does not like them*

Cognitive-preference tests first introduced by Heath (1964) have been increasingly in vogue up to the present times. "It is not an attempt to measure whether the student can identify correct or incorrect information, but rather what he is likely to do with information intellectually" (Heath, 1964). According to Harris (1974, p. 86), "most of the achievement testing in schools focuses on the 'can do' class of behaviours ... these are the knowledge, skill, ability types of objectives. But there may be other objectives, the achievement of which is evidenced by what the student typically does do. These are the attitude, interest, cognitive style types of objectives—perhaps more affective than cognitive". Cognitive preferences constitute a kind of cognitive style that deals with attributes of special relevance to the learning of science and science related subject matter (Tamir and Jungwirth, 1984). Tamir (1977) considered cognitive preferences as a variant of cognitive style. Cognitive preferences occupy a middle position on a cognitive-affective continuum (Tamir, 1976)

Bruner (1960) suggests that in the new courses emphasis was put on "a firm understanding of basic ideas that permeate the discipline rather than on technical vocabulary and practical applications".

In recent times, Indian education especially school science education has been the scene of considerable reform. The National Policy on Education (NPE) 1986, clearly states that science education will be strengthened so as to develop in the child well-defined abilities and values such as the spirit of inquiry, creativity, objectivity, the courage to question ... The science education programmes should be designed accordingly to enable the learner to acquire problem-solving and decision-making skills and to discover the relationship of science with health, agriculture, industry and other aspects of daily life (NPE, Government of India, 1986, p. 23). Intended curriculum objectives can become achievable objectives only when these are translated in the intended direction. This largely depends upon the teachers. The unique position of the teacher in our educative processes is further strengthened by the aptly made statement in NPE, 1986:

> The status of the teacher reflects the socio-cultural ethos of a society; it is said that no people can rise above the level of its teachers (p. 25).

It can be well argued that bringing changes in the curriculum and syllabus to revitalise the school education will remain useless so long as the teacher does not change himself, i.e., you change the syllabus and the textbooks but the teacher will teach only what he knows and prefers, so he moulds the system according to his own convenience. In Challenge of Education (Government of India, 1985), it is stated "whatever policies may be laid down, in the ultimate *analysis these have to be interpreted and imple*mented by teachers, as much through their personal example as through teaching-learning processes" (p. 55). The sponsors of BSCS in USA were fully aware of the pivotal position of the teacher, as epitomized by the statement (BSCS, 1962) that the BSCS fully recognises, that merely providing new curricular materials, however good they may be, will not necessarily result in improved biology teaching in secondary schools It may facilitate improve teaching, but the teacher remains the key Similarly, National Policy on Education, 1968 (p. 2) also says. "of all the factors which determine the quality of education and its contribution to national development, the teacher is most important".

All these lead us to suggest that cognitive preferences of teachers are of particular importance for improving instructional practices such as matching the students to teacher and the teaching method or fostering of alternative modes of cognition and stylistic approaches to problem solving. With the inception of cognitive preferences many evaluation studies were undertaken in connection with students and some with teachers. Because of the ideographic nature of the evaluation studies that have been undertaken, a need is felt to cite an example how cognitive preferences operate in teaching-learning situations This will provide a necessary ground work for understanding the ideas associated with cognitive preferences to secondary school teachers the consumers of our researches to improve classroom practices without which theory may find itself detached from reality.

It is felt that some discussion regarding how teachers' cognitive preference affects teaching is imperative to avoid unnecessary complication before taking up examples of cognitive preferences in operation.

A teacher taking up a unit for discussion in the classroom reflects his teaching preference during the course of his teaching. Instead of stating only cold and dry facts and rigid theories, classroom milieu may be made alive and dynamic by presenting factual scientific information in its varied connotations This is certainly not to suggest that teaching depends only upon individual idiosyncracy, and teacher will teach certain things and leave others simply because he does not like them. Rather, the excellence of the teacher' : performance becomes, at best, apparent while .> takes up certain aspects of knowledge and quite likely the identical behavioural norm of students get reinforced. Succinctly, although teacher puts his effort to cover the whole gamut of curriculum or syllabus, he spontaneously shows his preference for certain aspects of knowledge over others which automatically foster identical learning.

## Different Types of Cognitive Preferences

The four modes of "attending to scientific information" originally suggested by Heath (1964) are given here as reformulated by Van den Berg et al (1978):

*Factual Information or Recall (R).* Acceptance of scientific information for its own sake, i.e., without consideration of its implications or application. A preference for Recall indicates an interest in learning a name, a number, a definition, a formula, an observation, or a fact.

*Principles (P):* Representation or explanation of fundamental scientific principles. A preference for principles indicates an interest in identifying a relationship between variables, or a rule that can be applied to a class of objects, organisms, phenomena, or variables, or an interest in explaining phenomena.

*Questioning (Q):* Critical questioning of information for completeness, general validity, or limitations. A preference for questioning indicates an interest in critically analyzing and commenting on the validity of scientific information and/or in generating suggestions and hypotheses for further research.

*Application (A):* Application of scientific information in problem solving in real life situations: general, social and scientific context. A preference for application indicates an interest in using scientific information to solve problems in commerce, industry, farming, or in daily life.

## Sample Item

A typical test item comprises a heading referring to a topic and is followed by four alternatives each of which refers to the general topic, and is representative of one of the modes mentioned above. A sample item is quoted below:

The nervous system is an organized network of cells and fibres which accepts stimuli, reacts to them and regulates the activities of various organs in the body.

A. All impulses have a similar nature which may be characterized as electro-chemical. (P)

B. A normal nerve cell consists of 3 parts: the cell body, axon and dendrites. (R)

C. Do nerve cells undergo mitosis like other cells? (Q)

D. The knee reflex is used as an indicator of the adequate functioning of a human nervous system. (A)

The above item (S.No. 6) was taken from the Combined Cognitive Preference Inventory (CCPI) compiled by Pinchas Tamir (See Tamir, 1976).

## Cognitive Preferences in Operation

### *I. Teaching of Sample Items*

**Recall**

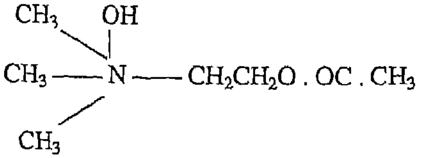
1. *Description of:* Nerve net, nerve cell, synapse, receptor cell, sensory neuron, reflex arc, reflex action, chemical composition, etc.
2. *Definition of:* Stimulus, polarization, threshold stimulus, conditioned reflex action, neurohormone, all-or-none response, etc.
3. *Name:* Name the different parts of human brain etc. Name the person who discovered conditioned reflexes, studied nerve impulse.
4. *Number:* Number of cranial nerves in frog and human brain. Nerve fibres that possess myelin sheaths transmit impulse at the rate of 120 metres per second.
5. *Giving Physical and Chemical Formula*

(i) *Physical Formula:* Conduction velocity of a bundle of nerve fibres can be studied by stimulating the nerve bundle at one end and recording compound action potential at the other. If the length of nerve in mm from the placements of the stimulating electrodes to the recording electrodes is noted ($L$) then the conduction velocity $V$ (m/sec) can be calculated:

$$V = \frac{L}{l}$$

where $L$ is the length of the fibre in mm and $l$ is the latency of action potential in m/sec.

(ii) *Chemical Formula.* Chemical formula of acetylcholine molecule.



$$CH_3 — \overset{CH_3 \quad OH}{N} — CH_2CH_2O\,.\,OC\,.\,CH_3$$
$$\underset{CH_3}{}$$

## Principles

1 The physiological properties of the nerve fibre vary with their diameter and medullation. The thicker the nerve fibres, the higher will be the impulse velocity, the lower will be the refractory period and stimulus threshold.

2. Although along the length of the nerve fibre impulses can travel in both the directions; however, under normal conditions the nerve impulse travels in one direction only—in the motor nerve towards the responding organ; in the sensory nerve towards the centre. This is due to the action of 'synapse'.

3. There is a period of time in man after the spinal cord has been severed when spinal reflexes seem to stop. For as long as six months the body seems to be completely paralyzed below the region where the spinal cord was damaged Only very gradually do movements begin to reappear in response to stimulation of the skin in lower part of the body. Eventually the flexion reflex becomes very vigorous again. The long period before the reflex reappears is interpreted to mean that normal function of the spinal cord is dependent on the constant transmission of controlling messages from the brain The spinal cord seems to need a long time to adjust to the loss of brain impulses. Although a similar situation exists in other animals, the spinal cord of man is more dependent because of the greater control from his relatively large brain. This is also obvious from the large amount of spinal cord space devoted to ascending and descending tracts that the brain exerts an important controlling influence over the segments of spinal cord.

4. If the stimulus is stronger than threshold, impulses will not travel any faster or be any stronger. Under normal conditions all impulses generated by equal to or above threshold stimulus travel along the neuron, at the same speed and with the same strength, the reason being the energy for conduction of the impulse comes from the neuron itself and not from the stimulus.

5. Nervous regulation and chemical or hormonal regulation are basically similar, no matter how unlike they may seem at first sight:

   (i) S → G → blood vessel → sensitive tissue

   (ii) S → N → sensitive tissue

   (iii) S → N → G → sensitive tissue

   (S is stimulus, G is gland, N is nerve)

   Methods of effecting nervous and hormonal control are thought to be somewhat similar as all of them involve in the transmission of chemical substances.

6. Recently evolved organism as compared to its primitive forms has more developed and advanced nervous system and, therefore, the man's brain sets him apart from all other animals. If we move along the evolutionary scale starting with certain protists and then the hydra and other coelenterates and finally the mammals and human being, the nervous system is gradually more and more differentiated and organized.

7. The impulses that reach the brain by way of the sensory neurons are all the same. Those from the eyes, the ears, and the pain receptors are identical. It is in the brain that the sensations of seeing, hearing, tasting, smelling, and feeling are experienced.

   Neurons can be stimulated to carry impulses by touching them. For example, if a neuron from the eye is touched there would be a sensation of seeing. Similarly if a neuron from the ear is touched there would be a sensation of hearing. Now suppose if the nerve from eye to brain is detached from the eye and connected to the receptor cell of the ear when under such case music is listened one would have the sensation of seeing—not hearing. All these exemplify the functioning or role of the brain in relation to various sensory receptors.

8. A child who is born deaf is also born dumb. The speech is the production of articulated sounds always bearing a definite meaning. Like all complex motor processes, the speech is brought about by the highest faculties of brain by the co-ordinated activities of a number of sensory, psychic and motor areas. When a baby learns speaking, it at first hears the sound of a spoken word. For speech, therefore, hearing is essential

## Questioning

1. There are no special nerve cells in plants and unicellular animals, but these organisms exhibit responses that may spread beyond the stimulated point. The sensitivity of these cells to stimuli indicates that response to stimuli is a general characteristic of most tissues However, in case of higher animals this is brought about by specialized nerve cells called neurons. How do you explain that such division of labour has a very high evolutionary significance?
2. What evidence shows that control by the nervous system is important to muscles?
3. It seems so obvious to us that even with our eyes closed we could know the position of our limbs—whether they are outstretched or at our sides. But suppose you have to explain this fact to a native of a primitive island. How do you do it convincingly?
4. Spinal cord is a hollow structure. Had it been a solid, what would have happened?
5. Presence of central nervous system has a special advantage in case of higher animals. What arguments can you advance for the idea that these advantages have led to the evolution of man and sets him apart from all other animals?
6. In spite of the presence of withdrawal reflex a tight rope walker on stepping on some sharp object, can retain the posture needed for proper balance Explain.
7. Interpret the following observations.
   - i. A person who cuts off a snake's head can later be bitten by the snake's head.
   - ii. A headless snake is able to wriggle
   - iii. A headless chicken is able to run.
8. In addition to the brain controlled activities of which we are aware what advantage might the brain provide to us by controlling a whole range of activities without our conscious knowledge?
9. If all impulses travel at the same speed and are of the same strength, how can a nerve fibre cause different strengths of response?

## Application

1. Like other cells, nerve cells also show changes of electrical potential during activity There is a more or less rhythmic increase and decrease of electrical activity in the brain. These measurable electrical changes or 'brain waves' give evidence of brain activity. With an instrument called electroencephalograph the waves can be detected, amplified and recorded. Such a record is called electroencephalogram (EEG). Changes in the brain activity have been noted (EEG) in certain diseases like cerebral tumours, meningitis, epilepsy etc. EEG is now widely used for measuring brain activity for the diagnosis and investigation of impaired cerebral functions, head injury, etc.
2. Studying reflexes has great importance in clinical diagnosis of certain diseases of central nervous system.

3. Understanding the properties of nerves helps us to develop drug like tranquilizers and sedatives.
4. Apart from other physiological changes it has been noted that galvanic skin response and some other electrical property of the nervous system changes under emotional stress condition. This property is used in lie detector, although less popularly, to detect lies told by human subjects.
5 Most of our habits are conditioned reflexes Hence, it is of immense personal and social importance It has great applied value in clinical and psychological medicine. With the help of conditioned reflexes cerebral centres can be localised.
6. There is now evidence that certain mental diseases may be caused by upset brain chemistry The chemical approach to the study of nerve function is important for the fundamental understanding of nervous system This approach is revolutionizing the study of mental diseases. Perhaps one day some mental diseases will be treated with specific chemical substances, just as the bone disease, rickets,. is now treated with vitamin D.
7 The regulation of heart beat is brought about by an accelerator nerve and inhibitor nerve with the release of chemical substances. This knowledge helps us to revive a dying heart by stimulating accelerator nerve or by using appropriate chemicals.

### *II. Achievement of Pupils*

Studies have opined that the role of the teacher in setting the intellectual tone of the pupil is an important factor in determining pupil achievement. The outcome or achievement of the pupil is a function of many variables. The pupil with his complex social structure and kaleidoscope of cognitive and psycho-sociological variables, cannot ignore the key place of teacher in teaching-learning situation in influencing their intellectual behavioural disposition. Although teaching in the classroom largely depends upon the nature of the curriculum and syllabus, the objective to be achieved, however, the essence of teaching is how ideas are presented. The presentation of idea and information is intimately connected with the teachers' own mode of preferences for different types of intellectual tasks. With the result, within the framework of curriculum and syllabus different blends in teaching can be seen and we often hear the statement that teaching is an art An artist not only reproduces what we see, he makes us see things. Similarly a teacher does not come in the classroom only to impart knowledge to achieve course objectives, rather he acts as a catalytic agent to initiate different kinds of intellectual developments among students sometimes deliberately and many a times unknowing while delivering lecture, answering and asking questions, providing discrepant situations, preparing term and examination papers, setting experiments in the laboratory, reinforcing and fostering particular kinds of intellectual endeavour and such other related activities.

In the above-cited example (Nervous System), it has been shown that cognitive preferences while in operation can be restricted only to factual information (or recall). Students exposed to such teaching cannot be expected to attend other modes of cognitive preferences, i.e., Principles (P), Questioning (Q), and Application (A). On the contrary, if the teacher during the course of his teaching takes up various aspects of scientific information representing R, P, Q and A naturally when pupils are exposed to a whole range of thought processes under such condition, pupil achievement will be affected.

## Curricular Preferences—Cognitive Preferences Symbiosis

It is worth considering the development that took place in the late 1970s Popperian and Kuhnian paradigms raising the substantive issues—what are the philosophical and epistemological bases of science education, and what is the nature of scientific knowledge? Popper (1972) states.

> "Thus it seems to me that it is the tradition of criticism which constitutes what is new in science, and what is characteristic of science".

In my opinion, despite the fact that the teachers are handicapped by the syllabus, what constitutes NCERT and SCERT school science programme would be very different if the teacher educators in pre-service and in-service teacher education programme urge teachers to pay heed to the origins of modern science, to the social conditions of the Renaissance, and to the emergence of a scientific world-view in the seventeenth century. This could lead to the identification of distinct levels within science education. The totalitarian features of the scientific perspective: the mathematical, analytic and experimental all combine to develop scientific knowledge an ordered collection of objective facts and theories. Secondly, all statements and facts in science are based on theory, and there is no distinction between theoretical and observational concepts. Thirdly, even then facts and theories are not safe from refutation. Last, but not the least, is the application of science which ensured the triumphant growth of science. Understanding all these practices will make a direct impact on the prevailing cognitive preferences of teachers, and will ensure them to rise above the constraints of the syllabus and simultaneously not deviating far enough from the method favoured in the syllabus.

## References

1. Bruner, J.S. 1960. *The Process of Education*, Cambridge, Harvard University Press, Massachusetts.
2. BSCS. 1962. "Biological Sciences Curriculum Study—Annual Report for 1961", *BSCS Newsletter No 12*. Boulder, Colorado.
3. Government of India. 1968. *National Policy on Education*. Ministry of Education and Social Welfare, New Delhi, Publication No. 1110.
4. Government of India. 1985. *Challenge of Education—A Policy Perspective*. Ministry of Education, New Delhi, Publication No. 1517.
5. Government of India. 1986. *National Policy on Education*. Ministry of Human Resource Development, Department of Education, New Delhi, Publication No. 1539.
6. Harris, C.W. 1974. "Problems of Objectives-Based Measurement". In Harris, C.W., Alkin, M.C. and Popham, W.J. (Eds.), *Problems in Criterion-Referenced Measurement*. Los Angeles: Center for the Study of Evaluation, University of California.
7. Heath, R.W. 1964 "Curriculum, Cognition and Educational Measurement", *Educational and Psychological Measurement*, 24 (2), 239-253.
8. Popper, K.R 1972. *Objective Knowledge* Oxford: Oxford University Press.
9. Tamir, P. 1976. "The Relationship Between Achievement in Biology and Cognitive Preference Styles in High School Students", *British Journal of Educational Psychology*, 46, 57-67.

10 Tamir, P. 1977. "A Note on Cognitive Preference in Science", *Studies in Science Education*, 4, 111-121

11 Tamir, P. and Jungwirth, E. 1984 "Test Scores and Associations as Measures of Cognitive Preferences", *Studies in Educational Evaluation*, **10**, 149-158

12 Van den Berg, E., Lunetta, V.N. and Tamir, P. 1978. "Cognitive Preferences: A Validation Study". Paper delivered at the Annual Meeting of the National Association for Research in Science Teaching, Toronto, Ontario.

# A Multipurpose Coil for Experiments in Electromagnetism

VED RATNA
**Professor of Physics**
**DESM, NCERT**
**New Delhi 110 016**

---

*The chief difficulty in this experiment is that without any ferromagnetic material being used, the coil has to be bulky Still its magnetic moment is very small.*

---

## The Problem

We teach in physics courses that a coil carrying direct current has a magnetic field similar to a bar magnet and thus acts like a magnet. To demonstrate it experimentally it is easy to have a coil of sufficient number of turns, pass a strong direct current (DC) through it and demonstrate the magnetic field by iron filings spread on a horizontal plane board, which has the axis of the coil in its plane. If weaker current is passed and is kept constant for sufficient time, the magnetic field can be plotted with the help of a plotting compass.

But the real thrill of demonstrating this concept is felt if the coil can be freely suspended like a compass needle and then it may align itself with its axis in the North-South direction under the influence of earth's magnetic field. This is easily accomplished if there is an iron rod inside the coil functioning as the core. But then it, in fact, demonstrates magnetisation of an iron rod by the coil carrying current Thus the demand of the concept is that this demonstration may be done without using any ferromagnetic material.

During the development of Physics Laboratory Manual of the NCERT, it was a matter of hot debate whether such an experimental demonstration is feasible. Though those discussions were inconclusive, the strong desire of the group that we should make this demonstration possible was very much evident. A thorough search of all available literature, Indian and foreign, led to only two sources where such a demonstration was mentioned.

(1) The physics textbook for Class X published by NCERT in 1986 mentions the following design, but it is too cumbersome and costly. It utilizes a coil of 1000 turns made on a cardboard tube about 20 cm long (used for shuttle cocks). A current of about 1 ampere is passed in it by a 6-volt battery (e.g., a motor cycle battery). The whole set-up is placed in a plastic trough and floated in water (Fig. 1) It consumes about 1.6 kg of SWG 20 enamelled copper wire.

(2) Another successful but equally cumbersome experiment was attempted by Prof. S.N. Datta of Regional College of Education, NCERT, Mysore. His coil was also about as big as in (1) above. It was fed current from an external source placed on the table. The coil was pivoted inside a bell-jar to avoid air droughts.

During the workshop for development of the Laboratory Manual members wished to make this equipment smaller and less costly. Some wished to go as far as to suggest that a button cell

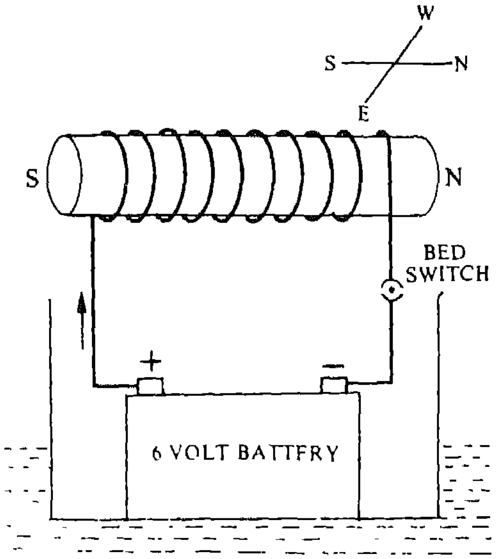


Fig. 1

with a small coil over it should be used. However, another member demonstrated that the button cell contains ferromagnetic material in it The author then consulted a talented electrical engineer in BHEL, who in his student days had designed for NSTS (National Science Talent Search) project a wick-type high efficiency kerosene oil stove which later became the forerunner of the now popular NUTAN stove *

The chief difficulty in this experiment is that without any ferromagnetic material being used, the coil has to be bulky. Still its magnetic moment is very small. Thus following objectives were set for developing an optimum design of the coil:

1 To minimise the size and weight of the coil.
2 To maximise the magnetic moment of the coil
3. To make efficient use of electric energy provided by a dry cell, which contains no magnetic material in it.

## The Optimum Design of the Coil

The large dry cell is of cylindrical shape having a diameter of 33 mm and length of 60 mm. A cardboard spool is made, in the core of which the cell just fits Thus the space for winding the coil in the spool has a length of 58 mm and diameter of 35 or 36 mm. Between 500 to 600 turns are wound on it by SWG 24 enamelled copper wire. It may have a resistance of between 4.2 and 5 5 ohm depending on the number of turns and how loosely these are wound Thus the 1.5 volt cell passes a current between 350 mA and 270 mA through it (Fig 2) Total weight of the coil is under 250 gram, out of which about 90 gram is due to the dry cell itself The coil with the cell in its core is suspended in the stirrup of a vibration magnetometer. More simply, it may be suspended in a laboratory stand using a monofilament nylon thread. This type of thread has no twists and thus it is easier to demonstrate the following steps:

(a) With no current in the coil, it remains practically stationary in any direction.†

---

* An improved version of the NSTS project along with detailed description of all experiments and data was submitted to the Government of India in the competition for designing a high efficiency wick-type kerosene oil stove held in the year 1975 Based on this entry of the competition, and with minor improvement in efficiency, the NUTAN stove was developed by a public sector organisation

† Due to low torsion constant of the mono-filament nylon thread, the suspended coil oscillates like a torsion pendulum with a very large time period of about 2 minutes or 3 minutes. Of course, the thread should not be too thick and should have a tensile strength of two to four times the weight of the coil and cell. Another good suspension consists of a few fibres taken from unspun silk Such number of fibres should be taken which just do not break by the weight of the coil If the fibres spread out while suspending the coil, they act like a bifilar suspension and have a large torsion constant. Hence it is necessary to make a knot at the upper end and also at the lower end

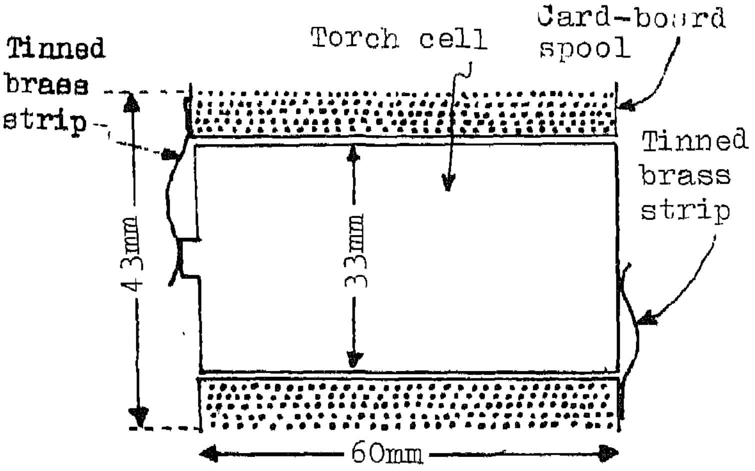


Fig. 2

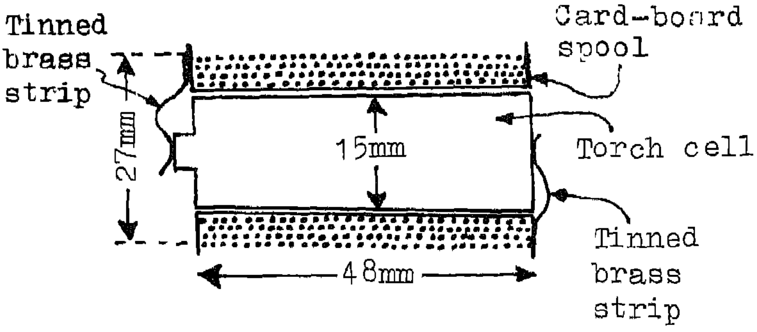


Fig. 3

(b) When the cell is connected and thus current is passed in the coil, it oscillates so that mean position of its axis is along the north-south direction. Time period of the oscillations is around 15 seconds. Thus 4 or 5 oscillations are demonstrated within less than 2 minutes.

Another version of this coil uses a medium size dry cell. The coil is made of SWG 26 enam-

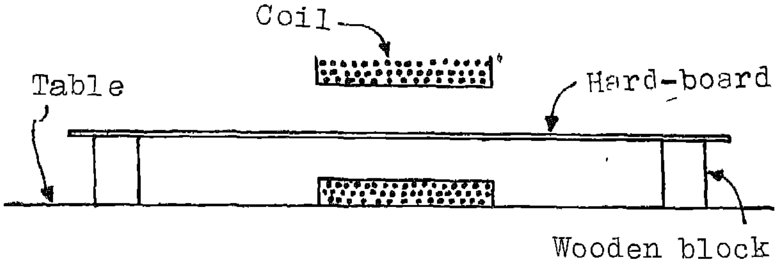


Fig. 4

elled copper wire having a resistance of between 5 ohm and 6 ohm. Third version of this coil uses a pencil cell and a coil of resistance about 6 ohm made of SWG 26 enamelled copper wire. Figure 3 shows the dimensions of the smallest version. It consumes about 57 m of wire, wound in 10 layers and weighing about 75 gram. However, the life of the pencil cell is much shorter than the other two cells

Using any version of the coil, the experiment can be demonstrated in a simple way without encasing it in a bell-jar to avoid the air droughts, *as the coil is compact and solid* In case, however, there are strong air currents produced by a ceiling fan or a table fan and the fan cannot be stopped, then a cylindrical transparent wall of glass or plastic around the suspended coil is needed

An alternative way of freely supporting the coil, without involving the elastic torsion of the thread is to place it in a small plastic trough and then float it on water in a larger trough. But, then, it is essential to take care that:

(a) The walls of the two troughs do not touch anywhere, and
(b) the coil does not get wet by water.

## Multiple Uses of this Coil

(i) The coil used for the large cell can be fixed *in the centre of a sheet of hard-board so that* smooth surface of the hard-board is co-planar with the axis of the coil (Fig. 4). The hard-board is adjusted horizontal with the help of a spirit level. Then fine iron filings are spread on the smooth surface of the hard board A current of about 1 ampere is passed in the coil with the help of a 6 V battery for a few minutes during which the hard-board is tapped gently. Iron filing become tiny induced magnets and arrange themselves and display the pattern of the magnetic field of the coil.

(ii) In the above set-up, a steady current of about 200 mA can be passed in the coil for about 1 hour with the help of a battery-eliminator. A sheet of paper may be attached on the hard-board and then the lines of force may be plotted with the help of a plotting compass.

(iii) 19 pieces of straight iron wires, each 15 cm long and about 5 mm to 6 mm diameter (commonly used to make clothesline) are taken. These are coated with enamel paint and then tied together firmly to make a stock of cylindrical shape. This makes an iron core for the coil (the largest version). Pass a current (DC) in the coil by a 1.5 V or 2 V source. Observe the effect of passing the current on a compass needle placed at some distance from the coil, with and without the core in the coil (Fig. 5). Thus infer the effect of iron core on the magnetic field of the coil.

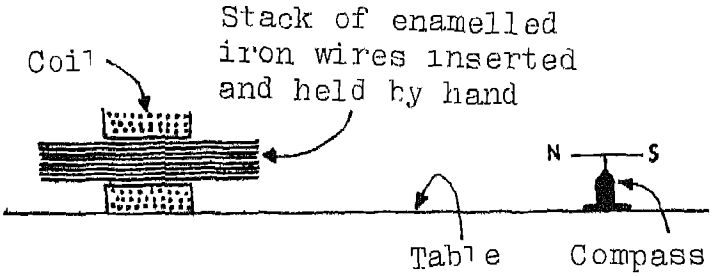


Fig. 5

(iv) Let the core stand vertical with the coil placed on the table around on it. Insert an aluminium ring with a hole of 40 mm diameter on the core. Pass an alternating current (AC) in the coil by a 12 volt AC source. Eddy currents induced in the ring make it to jump off (Fig. 6).

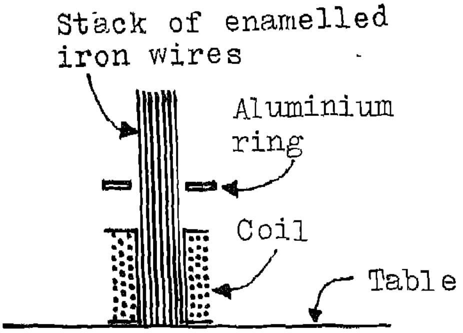


Fig. 6

(v) With the help of a magnet and galvanometer, the largest and the smallest versions of the coil can be used to demonstrate the phenomenon of electromagnetic induction and Faraday's Laws. The smallest of the three versions of the coil described above will easily slip into the largest one for this demonstration.

(vi) Any of the coils can be used as an air cored self-inductance and, with an appropriate iron core, as an iron cored self-inductance for various experiments. With various positions of the iron core, it can also function as a variable self-inductance.

## Acknowledgement

Thanks are due to Shri Deepak Kant of Bharat Heavy Electricals Limited, Hardwar, U.P., for his expert advice in designing the coil Thanks are due to Prof. V.G. Bhide for his insistence that this experiment must be possible and the various suggestions that he made towards this end Prof. K J Khurana deserves appreciation for experimenting with the button cell and consultancy during the entire project Shri T.S. Verma, Laboratory Assistant, deserves appreciation for his assistance during experimentation Last, but not the least, workers of Workshop Department, NCERT deserve appreciation for their cooperation in fabrication work.

# Planning Environmental Education at the National Level

---

*This article is but a brief summary of a new publication by the UNESCO-UNEP International EE Programme, entitled* **Environmental Education Handbook for Educational Planners**, *available in English to institutions requesting it by writing to* **Connect** *or to the National Institute of Educational Planning and Administration (NIEPA), 17B, Sri Aurobindo Marg, New Delhi 110 016, India*

---

Let us assume that national authorities have finally recognized the critical impact of environmental problems—pollution of the air, the earth and water; endangered ecosystems; the urgency of environmental solutions, and the key role of education and training in this field of national, indeed international, concern. What steps are to be taken to introduce environmental education into the national educational process at all levels and in all forms?

To begin with, a national environmental education (EE) strategy must be designed according to the specific conditions—economic, political, cultural, etc.—of the country. These form the unique combination, or framework, within which an EE planning team will perforce operate With regard to a national strategy for EE as a planning and management process, five critical factors might be listed·

- The first factor is the country's level of interest and commitment to EE—to be assessed in terms of national policies or budgets in the areas of education, environment and natural resources and also in terms of ideas and behaviour of political and educational leaders, citizens, educational practitioners and environmental professionals.
- The second key factor is the country's experience with national planning and management of educational efforts in general within which the national EE strategy must be made operational.
- The third factor necessary for designing a country's strategy is its past efforts and experiences with EE—which naturally vary widely from one nation to another.
- The fourth essential factor is the availability and potential of resources for planning and implementing the EE strategy—to be assessed in terms of leadership, implementing organizations, money and materials, skilled workers, professional and volunteer activists.
- The fifth, or last, factor to be assessed is the overall situation in the nation with regard to existing barriers to, as well as favouring forces for, really effective realization of a national EE strategy and plan

As for such a strategy and plan, six major initial actions are involved.

1. Formulation of a national policy on environmental education which clearly sets forth the country's commitment to the cause of EE and the national approach to be adopted for achieving EE goals and objectives
2. Preparation of short- and long-term plans for realizing the national EE strategy.

3. Formulation of specific programmes for implementing the EE strategy and plan.
4. Working out implementation strategies and tactics for putting the various EE programmes into operation.
5. Creation of the necessary institutional, organizational and management structures at both the national and local levels for this operation.
6 Developing a Management Information System (MIS) to oversee and ensure effective implementation, evaluation and improvement of the EE strategy and programmes.

Constitution of a National EE Planning Group, headed by the Minister of Education or any other appropriate authority, greatly helps start the initial planning activity and, equally important, assures the necessary support personnel for its implementation. In constituting the National Planning Group, it is necessary to bear in mind that the planning and implementation of environmental education, *both formally and non-formally*, calls for not only educational professionals but also other specialists, directly or indirectly involved with environmental concerns, *as well as* different socio-economic and ethnic groups. Involvement of people with such diverse interests and competencies can ensure that elements of the eventual EE action plan are truly relevant to the environmental needs and priorities of those most affected by environmental problems.

Ten steps have been devised for the process of developing an EE action plan: (1) specification of objectives, short-term and long-term; (2) identification of target groups; (3) conceptual framework (this is so basic it might be considered as a first step); (4) programme formulation and EE curriculum development (actually the operational framework for EE); (5) institutional arrangements; (6) implementation of EE programmes and curricula; (7) inter-agency coordination mechanism (ensuring proper linkages among the different partners involved in EE implementation); (8) development of the above-mentioned Management Information System, (9) resource planning and mobilization (involving establishment of priorities, in view of almost universally limited resources); and (10) research and development (so that EE planning and programming become a continuous process keeping pace with educational and environmental developments and changes).

As can be readily seen, introduction of environmental education into the national educational system is a complex task—not least because it involves not only the formal school system but also the loosely-defined and multiple channels of non-formal education for out-of-school youth and adults. Furthermore, members of the National Planning Group have to keep in perspective the currently existing parameters and situation of the nation's education efforts and try to integrate the environmental dimension into them. This may well require at times redefining the parameters and re-designing the basic components of the educational system which clearly poses a major problem for all educational planners of most countries.

Moreover, it can be seen that planning a national EE programme is not just a one-time affair. Rather, it must be a continuous process with a built-in capacity to adapt itself to the changing demands of the environment of the country as well as educational developments. Thus, the National Planning Group must present short-term EE action plans as well as a dynamic, self-correcting, long-term perspective for the nation's environmental education.

The next set of tasks, as has been pointed out, relate to evolving a suitable management system for implementing the action plans developed. This in turn involves identification of appropriate points in the existing educational system for introducing and integrating the EE components. It may also involve creation of new structures for providing the necessary organizational and academic support for implementing the EE programmes.

A major task is to create a management system which effectively encompasses field-level institutions and environmental activists. This requires considerable ingenuity on the part of the National EE Group to achieve a workable combination of planning and management strategies which incorporates effective vertical as well as horizontal linkages among the different agencies, institutions and individuals. The key factor is to mobilize and sustain community participation in all EE programmes, whether they are being implemented in the formal or non-formal educational process. This is imperative if environmental education is to be freed from the usual problems involved in introducing educational innovations, such as EE, through the hierarchical, bureaucratic structures that are so often characteristic of educational administrations in many countries.

It follows that EE planning and implementation urgently require an openness and breadth of scope on the part of educational authorities, at both the national and the local level. Indeed, it is at the local level that administrators ensure that national plans and policies concerning environmental education are truly implemented *and effectively updated* by their providing a continuous feedback to national planners regarding local realities. It is thus essential that there be training programmes to develop the necessary EE knowledge, skills and environmental attitudes among key personnel working at the various levels of educational planning and administration

Courtesy: *Connect*

# A Discriminatory Study of Achievement of Students in Physics Taught through Lecture Model and Individually Guided System of Instruction

LALIT KISHORE
**Principal**
B.K. AGGARWAL
**Post-graduate Teacher (Chemistry)**
**Kendriya Vidyalaya No. 2**
**NFL Township, Bathinda 151 003 (Punjab)**

---

*The Mastery Learning Strategy (MLS) of classroom instruction in physics, based upon the concepts of structured subject matter, self-pacing, peer-tutoring, individual guidance and criterion-testing, has positive cognitive consequences. The present study of implementing mastery-based Individually Guided System of Instruction (IGSI) in physics developed by the NCERT has revealed that an achievement test in physics loses its discriminatory power under the mastery learning situation. Thus, IGSI-physics can be helpful in making learning optimal by shifting more students to higher grades of achievement.*

---

## Introduction

Based upon the mastery learning concept (Keller, 1968; Bloom, 1971), the National Council of Educational Research and Training (NCERT) developed an instructional material in physics called the Individually Guided System of Instruction (IGSI). It has been reported by some investigators (Mathur, 1983; Hooda, 1984, Kaundal, 1984) that the mastery based instructional procedures have positive cognitive consequences.

A review of the studies done on IGSI reveals that hardly any investigator has tried to find the efficacy of this instructional model on achievement (Kishore, 1986) Therefore an attempt was made to investigate the effect of IGSI on achievement by finding the change in the discriminatory index of a teacher made achievement test by implementing this instructional model.

It will be appropriate here to throw more light on the IGSI-physics material which was used for the present study. IGSI-physics in the instructional material structured into sequential learning blocks called study units. The student paces himself through the study units with his difficulties removed by taking individual guidance from the peers and the instructors. As and when the student thinks that he has mastered his ongoing unit, he takes a mastery test on the unit which he should pass with more than 80% marks before he is allowed to proceed on to the next unit.

### Objectives of the Study

The present study entails the following objectives:

1. To study the effect of IGSI on achievement in physics.
2. To study the effect of IGSI on high cognitive entry behaviour group of students.
3. To study the effect of IGSI on the low cognitive entry behaviour group of students.

### Hypotheses

The following hypotheses stated in the null form were tested:

H1: There will be no significant variation in the discriminatory power of the test after the IGSI treatment.

H2: The number of wrong answers by the high group students would not decrease after the IGSI treatment

H3: The number of wrong answers by the low group students would not decrease after the IGSI treatment.

### Tools

The following tools were used for the present study:

1. Cattell's culture fair intelligence test (reliability = .87, concept validity = .85, concrete validity = .77).
2. An achievement pre-test in physics developed locally by the investigators (split half reliability = .65; number of test items = 50).
3. An achievement post-test in physics developed locally by the investigators (split half reliability = .68; number of test items = 50).

### Sample

Fifty students of Class XI studying in the Motilal Nehru School of Sports, Rai (Haryana) constituted the sample for the study. The age of the students ranged from 15 to 17 years. The two comparison groups, consisting of 25 students each, were matched on intelligence. The high and low groups of students comprised of 25% of the high and low rankers on the pre-test scores. These groups consisted of six students each

### Procedure of Study

The study was done using the 'control and experimental groups design'. The experimental group was taught physics through the IGSI and the control group was taught through the lecture model. The investigator taught both the groups For the experimental group, the prescribed guidelines for implementation of IGSI were followed with 80% marks as the criterion for mastery.

The post-treatment achievement test was administered after six weeks of IGSI course to investigate the change in discriminatory index of the test.

### Statistical Computations

The statistical computations for matching the two comparison groups were done by the t-test and level of significance of the difference in their intelligence. Also, the discriminatory index of the pre-test and post-test were found before and after the experiment for the two comparison groups.

It will be proper to explain the discriminatory index at this point The discriminatory index of test is its ability to discriminate the students of different achievement levels. For calculating the discriminatory index the following formula (Lindeman, 1971) was used:

$$D = \frac{WL - WH}{N}$$

**TABLE 1**
**Pre- and Post-treatment Discriminatory Index of Achievement**
**Two Comparison Groups ($N = 12$)**

| Group | Test | Mean Wrongs in Low Group $WL$ | Mean Wrongs in High Group $WH$ | Discriminatory Index $D = \frac{WL - WH}{N}$ |
|---|---|---|---|---|
| Control | Pre-test | 16 | 9 | .58 |
| | Post-test | 14 | 8 | .50 |
| Experimental | Pre-test | 16 | 10 | .50 |
| | Post-test | 10 | 8 | .17 |

where $D$ is the discriminatory index, $WL$ is the mean of wrongs in the test for the low group, $WH$ is the mean of wrongs in the test for high group and $N$ is the total number of students in high and low group.

A test is able to discriminate between the students of different achievement levels effectively if value of the discriminatory index is between 0.4 and 0.6.

## Findings

The findings of the study are summarised in Table 1.

The following interpretations emerge from the findings of the study:

1. The discriminatory index of the control group following the lecture method of instruction after the treatment changed from 0.58 to 0.50. Thus, for the control group the discriminating index remained between 0.40 and 0.60.
   On the other hand, the discriminatory index of the test showed a drastic change from 0.50 to 0.17 for the experimental group, thereby rejecting hypothesis H1.
2. For the high group of the experimental group following IGSI, the mean number of wrongs in the answers of the test items changed brought about insignificant variation the discriminatory index thereby accepting hypothesis H2.
3. For the experimental low group the mean wrongs in the answers of the test items decreased from 16 to 10 thereby rejecting hypothesis H3 (It should be noted that 10 is the mean wrongs of the high group of the control group).
   This change brought significant variation, in the discriminatory index. Thus, the test which was good in the lecturing situation, lost its discriminatory power in the mastery-based instructional setting.

## Discussion

The findings, thus, reveal that IGSI has positive effect upon achievement in physics; and more so for the low group students. In other words, the low achievers when treated with IGSI move towards high group. Similar effect of mastery learning models has been reported by (Yadav, 1984; Kaundal, 1984; Kishore, 1986) using the t-test and U-test techniques. It seems that the insistence on mastery, self-pacing, individual guidance, peer-tutoring (the built-in features of IGSI) have positive cognitive effects on students. It also becomes evident that in lecturing situation students learn no more than they would otherwise learn by mere chance. On the other hand, in the mastery learning situation, more students achieve higher grades. It may be concluded that IGSI is a superior method of instruction than the lecture method.

## References

1. Block, J.H. *Mastery Learning: Theory and Practice*. New York: Holt, Rinehart and Winston Co., 1971.
2. Bloom, B.S. "Learning for mastery", *Evaluation Comments*, 1 (12), 1968.
3. Hooda, R.C. "Effect of Mastery Learning Strategy on Achievement in Mathematics, Self-concept and Attitude towards Mathematics", *Journal of Educational Research and Extension*, 1, 1983.
4. Kaundal, R.C. *Effect of PSI and Bloom's Mastery Learning Strategy on Retention of High School Students on a Segment of Science*. Unpublished Doctoral Thesis, H.P. University, Shimla, 1984.
5. Keller, F.S. "Goodbye Teacher", *Journal of Applied Behaviour Analysis*, 1, 1968.
6. Kishore, L. *Effect of Mastery Learning Strategy upon Achievement and Scientific Attitude*, Unpublished Doctoral Thesis, Punjab University, Chandigarh, 1986.
7. Lindeman, R.H. *Educational Measurement*, Bombay: Taraporevala Sons and Co., 1971.
8. Mathur, R.N. *Guidelines for Implementing IGSI*. New Delhi: National Council of Educational Research and Training, 1983.

# Students' Query About the Number π

SURJA KUMARI
**Department of Education in Science and Mathematics**
**NCERT, New Delhi 110 016**

*In order to facilitate teaching-learning process, this paper presents a detailed information about the number π in the historical context of its evolution.*

A common query has been raised by several students of age group 11+ to 13+ about the number π viz., 'why do we say π is an irrational number and take its value 22/7, which is a rational number'? They have shown by simple division algorithm that 22/7 is $3.\overline{142857}$, a non-terminating but recurring decimal number. A simple answer to this query that the rational number 22/7 is only an approximate value of π taken for computational purposes does not seem to serve the purpose. One needs to find the root cause of this query. For this purpose a survey was conducted in schools with the intention to probe into classroom teaching methodology which might have led to this serious misconception.

Three schools of different category, viz., unaided, aided and government schools of Union Territory of Delhi of south campus were randomly selected for conducting the survey. A small sample of ninety students of Class VIII, thirty from each school, was chosen and a test was conducted in the usual classroom situation The students were asked to write in detail the meaning, definition and uses of the number π. It was observed that, on the whole students were lacking the basic understanding about the number π. Only 5 per cent could give correct definition, emphasising that its value is taken 22/7 *approximately* for calculation purposes. Discussion with teachers regarding the poor performance of the students revealed that the number π is casually mentioned in the classroom teaching as and when its reference comes in the textbook. No efforts are made to explain its historical development and applications since such information is not available in the instructional material It was concluded that the root cause of the students' misconception about the number π has arisen due to inadequate teaching in the classroom and lack of reading material dealing with such concepts in the schools.

In order to facilitate teaching-learning process this paper presents a detailed information about the number π in the historical context of its evolution.

The most famous problem in the history of mathematics is 'squaring the circle', that is, constructing a square equal in area to that of the given circle. This problem has exercised a greater or longer attraction of researchers in mathematics right from the infancy of geometry. The problem of finding area had its genesis in the daily life situations for example when measuring of area of agricultural field had become a necessity in the Nile valley as each year the floods would blot out every mark made by the farmers. To cater to these needs, methods were devised to find the area of a figure bounded by straight lines. But tremendous difficulties were faced in finding the area of a figure bounded by curved lines. So every problem of this type was reduced into one of measuring areas with straight edges first. This way the problem of 'squaring the circle' originated. Clearly, if a square can be constructed with the area of a given circle, by measuring the area of the square, that of the circle is determined The expression squaring the circle derives its name from this approach and is the first problem which involves π. The number π (pi), a Greek alphabetical symbol, is the ratio of the circumference of a circle to its diameter. The area of a circle of radius $r$ is $\pi r^2$ and the areas of the square of side A is $A^2$. The algebraic expression

$$A^2 = \pi r^2$$

or

$$A = r\sqrt{\pi} \qquad ...(1)$$

expresses the equivalence in area between the square and the circle. Hence for a given radius of the circle the problem of squaring the circle basically reduces to the computation of the value of π. The first scientific attempt in this direction seems to be due to Archimedes who is usually remembered for his mechanical inventions in the area of mechanics and hydrodynamics, but his contribution to mathematics was significant in his times. He calculated the value of π by the method known as the 'process of exhaustion'. This method was first used by Antiphon by drawing regular polygons inside the circle (see Fig 1) by successively doubling the number of sides until the area between inscribed regular polygon and circle was approximately exhausted. But he could not find the solution.

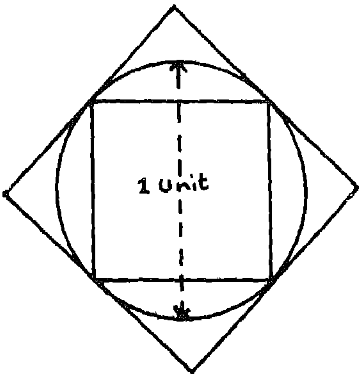


Fig. 1

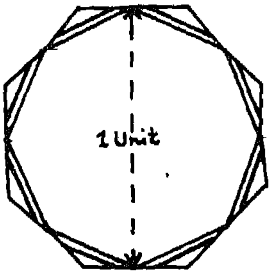


Fig. 2

Archimedes improved upon his method by inscribing and circumscribing regular polygons, as shown in Fig. 2, to find the limits within which the circumference of a circle must lie. By successively making these limits draw closer and closer to each other he found that the values or π lie between 223/71 and 220/70. That is, the circumference of a circle was little more than 223/71 times its diameter and little less than 220/70 times its diameter It can be shown by calculations or careful measurements that as the number of sides in the polygons increases, the difference in the perimeters of circumscribed and inscribed polygons decreases. The perimeters of such polygons for a circle of unit diameter are tabulated in Table 1.

**TABLE 1**

| Number of Sides | Perimeter of Inscribed Circle $P_i$ | Perimeter of Circumscribed Polygon $P_c$ | Difference $P_c - P_i$ | Value of π $\pi = \frac{1}{2}(P_i + P_c)$ |
|---|---|---|---|---|
| 4 | 2.8 Units | 4.0 Units | 1.20 | 3.4 |
| 6 | 3.0 ″ | 3.46 ″ | 0.46 | 3.23 |
| 8 | 3.0 ″ | 3.3 ″ | 0.30 | 3.19 |
| 12 | 3.1 ″ | 3.2 ″ | 0.10 | 3.6 |
| 18 | 3.135 ″ | 3.173 ″ | 0.078 | 3.15 |
| 24 | 3.13 ″ | 3.16 ″ | 0.03 | 3.145 |
| 36 | 3.139 ″ | 3.15 ″ | 0.011 | 3.144 |

Archimedes used regular polygons with 96 sides in order to get best possible approximation for π. Since then several researchers have worked on this problem. They include Tsu Chung-chih of China, Aryabhata and Bhaskara of India, Ptolemy of Alexandria. French mathematician Francois Viete found the value of π correct to ten decimal places using polygons having 393.216 sides. He also discovered the following interesting infinite product

$$\frac{2}{\pi} = \frac{\sqrt{2}}{2} \frac{\sqrt{(2+\sqrt{2})}}{2} \frac{\sqrt{(2+\sqrt{2}+\sqrt{2})}}{2} \cdots$$

Adrianus Romanus of Netherlands using $2^{30}$-sided polygons found the value of π correct to 15 decimal places, whereas Rudolph Van Ceulen of Germany computed the value correct upto 35 decimal places using $2^{62}$-sided polygons. But the number π reached its maturity with the invention of calculus. the Greek method was abandoned and purely algebraic device of convergent infinite series, products and continued fractions came into vogue. The English mathematician John Wallis obtained the following expression

$$\frac{\pi}{2} = \frac{2 \cdot 2 \cdot 4 \cdot 4 \cdot 6 \cdot 6 \cdot 8 \ldots}{1 \cdot 3 \cdot 3 \cdot 5 \cdot 5 \cdot 7 \cdot 7 \ldots}$$

and Lord Brouncker converted this expression into continued fraction

$$\frac{4}{\pi} = 1 + \cfrac{1^2}{2 + \cfrac{3^2}{2 + \cfrac{5^2}{2 + \ldots}}}$$

The infinite series,

$$\text{arc tan } x = x - \frac{x^3}{3} + \frac{x^5}{5} - \frac{x^7}{7} + \ldots, \quad (-1 \le x \le 1)$$

obtained by Scotch mathematics James George viz., becomes for $x = 1$ the Leibniz's infinite series

$$\frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \ldots$$

The successive products and sums of the terms of these series yield values of π as accurately as desired.

Count Buffon, the eighteenth-century naturalist, in his most famous 'Needle Problem'

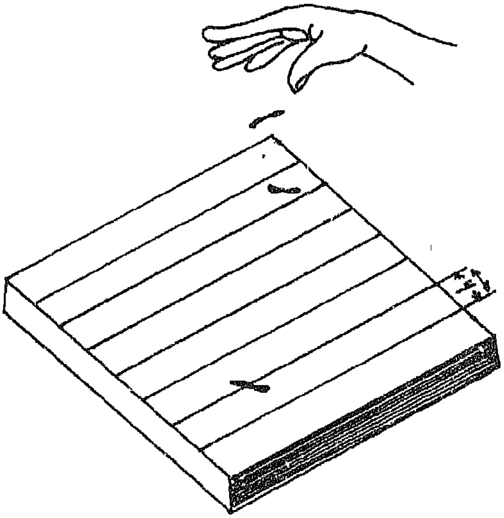


Fig. 3

experiment showed π as a measure of probability He took a plane surface (see Fig. 3) which is ruled by parallel lines, the distance between the lines being equal to *d*. Taking a needle whose length *l* is less than *d*, Buffon dropped it on the plane surface permitting it to fall each time on the ruled surface. The toss was considered favourable when needle fell across a line, unfavourable when it rested between two lines. The ratio of successes to failures was an expression in which π appears. The larger the number of trials the more closely did the result approximate the value of π. An Italian mathematician Lazzerini elaborated this experiment by making 3,408 tosses giving a value for π equal to 3.1415929, an error of only $3\times10^{-7}$.

We have seen π in three guises, as the ratio of the circumference of a circle to its diameter, as the limit of infinite series and as a measure of probability.

Value of π correct up to 2035 decimal places was obtained in 1949 by using Electronic Calculator ENIAC at the Army Ballistic Research laboratories in Aberdeen, Maryland, USA. More accurate calculations of π with the help of computer are being carried out by researchers with different methods these days It may be noted that $\pi \neq 22/7$, the number $\pi = 22/7 = 3\ 14$ gives value of π correctly only up to the hundredth place which is good approximation for routine computation The above historical background has shown that for centuries mathematicians studied and investigated the properties of π. It took about four thousand years to find exactly what kind of number it is. It was Lambert who first proved rigorously that the number π is irrational. He showed that if *x* is rational, but not zero, then tan *x* cannot be rational; since $\tan \pi/4 = 1$, it follows that $\pi/4$ or π cannot be rational C L F. Lindemann in 1882, proved the transcendentality of the number π. He showed that the number is not only not the root of first or second degree algebraic equation but is not the root of any algebraic equation. Thus π is a transcendental number. Here, then is the end of every hope of proving the classical problem 'squaring the circle' in the intended way, a mathematical impossibility.

The idea of the number π helps to find area of a circle. It also helps us to find the circumference of a rim of a wheel if we know the spoke or what size of spoke we need to make a rim which turns so many times in a km and the importance of wheel is well known. It is the basis of the cyclometer (the first model of which was made in Alexandria about 100 B.C ) and the speed indicator. It is also the basis of large earth measurements and estimates of the size of sun and the moon. Lastly one can rightly assert that without π there would have been no Columbus and no George Stephenson

## References

1. Kasner, E. and Newman, J. *Mathematics and its Imagination.* Simon and Schuster, New York.
2. Hogben, L. *Mathematics for the Million.* George Allen and Unwin Ltd., London.
3. Hooper, A. *Makers of Mathematics.* Faber and Faber Limited, London.
4. Howard, E. *An Introduction to the History of Mathematics.* Holt, Rinehart and Winston, London.

# Nobel Prizes in Science for 1990

---

*Nobel Prize gold medallion and diplomas were presented by King Carl XVI Gustav of Sweden to ten laureates in Physics, Chemistry, Medicine, Literature, Peace and Economics. A special ceremony was held on 10th December, 1990. The names of recipients were announced earlier in the month of October.*

*Instituted by the will of a single person, Alfred Nobel, the famous Swedish chemist and inventor of the dynamite, the Nobel Prize is awarded every year to the persons who have made greatest contribution towards human welfare in different fields. The award was made for the first time in 1901 from the fabulous fortune left by Nobel for the purpose*

*The Nobel Prize is now considered the highest international recognition. Though finally judged by a few represented on committees, academies and institutes located at a small corner of the world, the award is looked upon as universal appreciation of genius. Fortunate are the persons who receive such an honour in their life time. Proud are the countries who hold them. The prize also makes a good piece of work known, understood and appreciated in a much wider circle. The money and recognition attached to the award has helped many in carrying out further research.*

*Here is a glimpse of the Nobel Prize winners of 1990 in Physics, Chemistry and Medicine together with brief outlines of their work.*

Editor

---

## Physics Prize Awarded to Two Americans and a Canadian

The Noble Prize in physics for the year 1990 has been awarded to two U S. scientists and a Canadian for breakthrough discoveries about minute particles that form more than 99 per cent of all matter on Earth.

The Royal Swedish Academy of Sciences announced October 17 that Americans Jerome Friedman, 60, and Henry Kendall, 63, both professors at the Massachusetts Institute of Technology, and Canadian Richard Taylor, 60, a professor at Stanford University, shared the 700,000-dollar award.

The academy said that the three physicists, in pioneering work carried out during the late 1960s and early 1970s, were the first to find evidence of quarks, now believed to be the basic building blocks of matter.

"Here was a repetition, although at a deeper level, of one of the most dramatic events in the history of physics, the discovery of the nucleus of the atom," the academy said in its citation. It added that their work "paved the way for further investigations of the innermost structures of matter."

The physics laureates showed that the protons and neutrons that make up the nucleus of an atom, and formerly thought to be fundamental particles, were made up of even smaller components called quarks. The discoveries were made using the Stanford Linear Accelerator, an "atom smasher" that produces high-speed collisions of subatomic particles in an effort to discern their properties and structure.

Atoms that make up all familiar matter consist of tiny subatomic particles. Protons, carrying a positive electric charge, and electrically neutral particles called neutrons, cluster within the atom's central region or nucleus. Whirling around the nucleus is a third subatomic particle,

**Fig. 1.** *Three North American scientists whose experiments confirmed the existence of quarks—tiny packets of energy described as fundamental building blocks of all matter—shared the 1990 Nobel Prize in Physics. Dr Henry W. Kendall (left) and Dr. Jerome I Friedman (centre) are professors at the Massachusetts Institute of Technology. Dr Richard E. Taylor (right), a Canadian, is on the faculty of Stanford University, in California, where the three met as graduate students The physicists' experiments at Stanford's Linear Accelerator Center from 1967 to 1973 achieved a "breakthrough in our understanding of matter," according to the Nobel Committee.*

the electron, which carries a negative charge. Electric current consists of flowing electrons.

Physicists now know that protons and neutrons are made up of combinations of quarks, bonded together according to their "colour", a special property that enables quarks to join and form new particles. A quark's electric charge determines its "flavour"—whether it is "up" or "down".

A proton consists of two "up" quarks with a positive charge of two-thirds each and one "down" quark with a negative charge of one-third, together yielding a single positive charge. In a similar way, one "up" and two "down" quarks combine to form a neutral neutron.

More recently researchers have discovered special kinds of matter that are different than the type from which the everyday world is made. These fundamental particles, which include quarks called "charmed", "strange", "top", and "bottom", are created by high-energy particle accelerators or carried by cosmic rays.

Friedman told reporters that the research he and his colleagues performed represented the first experimental evidence that quarks existed and confirmed earlier theories. The breakthrough research began with the study of protons.

"To our surprise, we found that the scattering of electrons from protons behaved in a way that suggested that there were point-like objects inside, little nuggets inside," he said. "They were later identified . . as being compatible with there being quarks."

Friedman said that their research contributed to an understanding of how nature works

"One never knows what the application of basic research will be," he said "Knowing what the structure of matter is ultimately has to have some effect on how you model the entire structure of things."

Taylor, who was born in Medicine Hat, Alberta, Canada, noted that their research, involving the acceleration of protons in order to better examine their structures, started an even longer process where more quarks were discovered.

"This was one step in the chain to forge that essential understanding we have now of the elementary particles," he said.

Ingvar Lindgren, a member of the Royal Swedish Academy, told reporters that although the research has had little immediate practical application, the new understanding of nature it provided helps researchers in many scientific areas.

"This is ground research which has increased our understanding of nature and changed our picture of the world," he said

## Nobel Chemistry Prize

A U S. scientist has won the Nobel Prize in chemistry for research that simplified the production of plastics, drugs and other products used throughout the world.

The Royal Swedish Academy of Sciences said on October 17 that it awarded the prize worth about 700,000 dollars to a 62-year-old professor at Harvard University, Elias Corey, for developing simpler ways to make complex chemicals. Corey was also one of the first to use computer graphics to speed up the synthesis of new chemicals.

The academy cited Corey for "his development of the theory and methodology of organic synthesis." Organic synthesis is the production of complicated biological compounds using simple and inexpensive starting materials.

The academy said that Corey synthesized about 100 important drugs and other natural products, and that his research simplified the production of plastics, paints, dyes and pesticides. These products "have contributed to the high standards of living and health and the longevity enjoyed ... in the Western World," the academy said.

Corey's method of synthesizing chemicals is called retro-synthetic analysis. This involves taking a chemical structure and manipulating it in the laboratory in a stepwise way to identify a series of simpler molecules needed to construct the original compound.

This direction of thinking was the reverse of the usual way of thinking of synthesis, which involved starting out with simpler compounds in an attempt to form a more complex substance. Corey's initial work, which made use of formal strategies that involved a minimum of trial and error, was often greeted with ridicule by colleagues who thought natural products were too complex to be dealt with in such a manner.

In the mid-1960s, Corey also became the first to use computer graphics to portray chemical structures and developed the beginnings of machine-generated retro-synthetic analysis. Today computers and laser printers are used throughout the world to generate models of possible chemical structures and speed up the creation of new products.

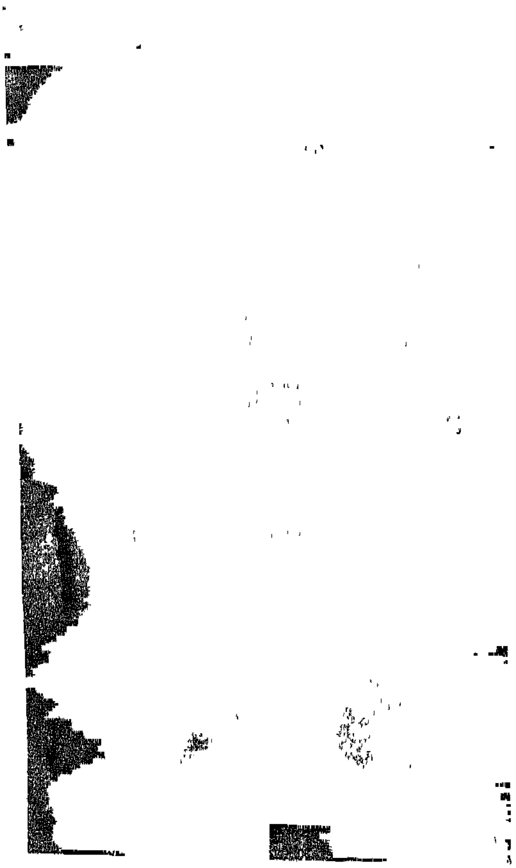


**Fig. 2.** *The laureate in Chemistry, Dr. Elias James Corey (left), of Harvard University, was honoured for developing new ways to synthesize complex substances, including pharmaceuticals, patterned after natural molecular structures.*

In early 1968 Corey completed the first synthesis of prostaglandins, a group of fatty acid derivatives affecting many body tissues and organs including the prostate gland, brain, lungs, kidneys, thymus and pancreas. However, the availability of these biological regulators from natural sources for therapeutic use was extremely limited.

"The first synthesis was done with practically no knowledge of the chemical properties of these compounds," Corey told reporters recently. "Such small quantities had been available that there was very little information in the literature."

Just last year Corey described six major synthesis, including a total synthesis of an extract from the *Ginkgo biloba* tree, which could prove to be a treatment for several conditions ranging from asthma through mental dysfunction to various circulatory disorders.

Corey sees an exciting future for organic chemistry in the decades to come. "It will encompass areas outside the traditional ground, towards biology, medicine, genetics and the many elements available in the Periodic Table," he said recently. "The revolution that this decade has seen will continue into the next 50 years. The growing power of modern synthesis will be central to the development of therapeutic agents for years to come."

Corey, born in Methuen, Massachusetts, in 1928, earned his doctorate degree in chemistry at the Massachusetts Institute of Technology in 1950. He has been a professor at Harvard University since 1959.

### U.S. Transplant Pioneers Awarded Nobel Medicine Prize

The Nobel Prize for Medicine has been awarded to two U.S. doctors who pioneered the first successful organ and bone marrow transplants to save the lives of severely ill patients.

The 730,000 dollar prize would be shared by 71-year-old Dr. Joseph Murray, a surgeon at the Brigham and Women's Hospital in Boston, who performed the first kidney transplant, and 70-year-old Dr. E. Donnall Thomas, a researcher at the Fred Hutchinson Cancer Research Center in Seattle, who perfected the use of bone marrow transplants to treat leukemia and other diseases.

"Murray's and Thomas' discoveries are crucial for those tens of thousands of severely ill patients who either can be cured, or be given a decent life when other treatment methods are without success," the institute said in its official citation. "This year's laureates paved the way for transplantation in man."

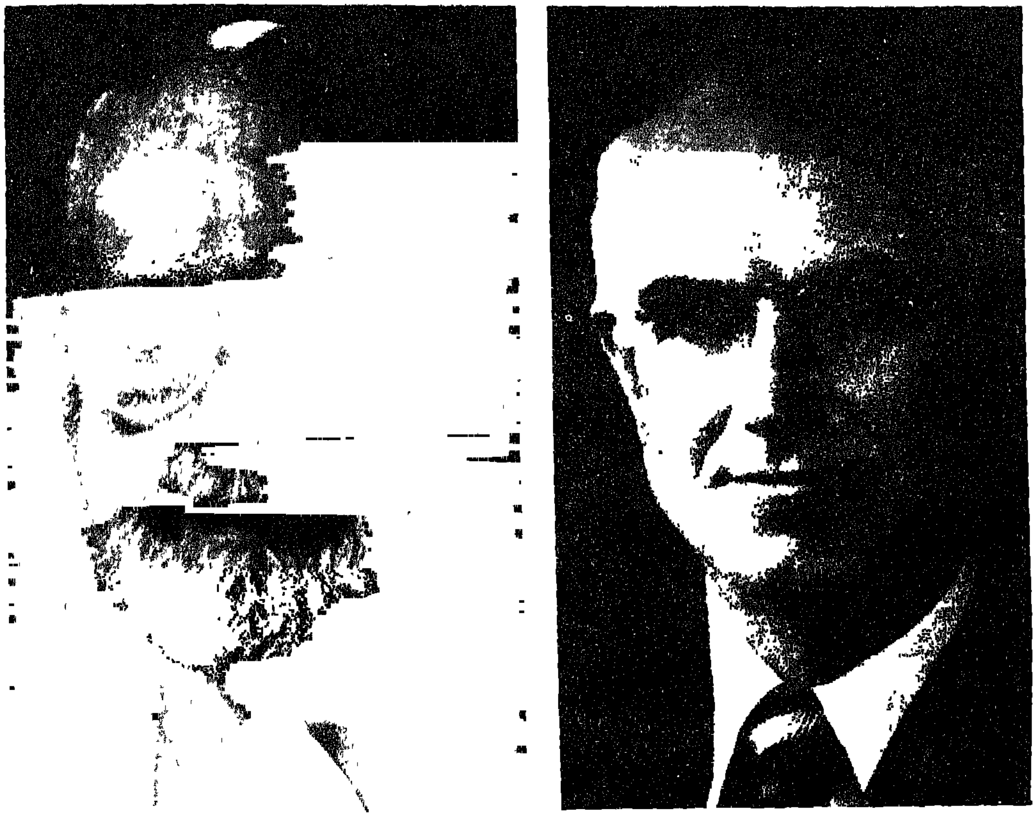


**Fig. 3.** *Two Harvard-trained physicians shared the Nobel Prize in Medicine for their pioneer life-saving transplants in the human body. Dr. Joseph E. Murray (right) and Dr. E. Donnall Thomas (centre) were residents together at Boston's Peter Bent Brigham Hospital, where Dr. Murray still practises. He solved the problem of organ rejection and in 1954 made the first successful organ transplant, a kidney from one identical twin to another. Dr. Thomas, now with the Fred Hutchinson Center in Seattle, Washington, performed the first bone marrow transplant in 1956.*

In December 1954, Murray performed the first human kidney transplant on two men who were identical twins, thus presenting no immunological problems The landmark operation began the era of transplant surgery. The field gained broader application when in 1962 Murray and several colleagues succeeded in solving the problem of organ rejection using the immunosuppressive drug azathioprine.

The first success transplanting an unrelated cadaver kidney into a live patient was achieved in 1962, and by 1964 the success rate of transplanting kidneys from unrelated donors had reached 75 per cent. Murray's colleague in this work, chemist Dr. George Hitchings, won the 1988 Nobel Prize for developing azathioprine and other life-saving drugs

Murray, who began experiments transplanting kidneys between dogs in the 1950s, told reporters that his research initially met with great skepticism from other scientists who doubted that the body's immune system would accept a foreign organ. Today tens of thousands of patients have kidney transplants each year. Murray's work showing that kidney transplants could work led surgeons to begin transplanting other vital organs.

Murray also spent part of his time as a plastic surgeon, concentrating on patients who had been in serious accidents or had birth deformities He introduced into the United States a procedure that corrected head deformities by resectioning and moving the bones of the head and face forward.

Thomas pioneered the bone marrow transplant procedure, a therapy that is now considered the only hope of survival for tens of thousands of patients with certain leukemias and other blood-related and genetic disorders.

Bone marrow refers to the soft tissue found in the hollow centre of many human bones that produces blood cells and platelets. In leukemia some of the body's white blood cells become cancerous and gradually crowd out the normal blood-producing cells of the bone marrow.

Thomas pioneered a technique by which leukemia patients were given a healthy supply of bone marrow after their own diseased or damaged blood cells were killed by high-dose chemotherapy Thomas began with identical twins, performing the first bone marrow transplant in 1956. Later he demonstrated that transplants also could be done between unrelated individuals, provided that the immune systems of the donor and recipient could be carefully matched.

"In the 1950s, most people thought this would never succeed," he told reporters. "And in the 1960s, even people who had worked on it in the 1950s had given up. But we were convinced it could work."

As director of the Hutchinson Center's clinical division for over 15 years, Thomas headed the largest marrow transplant program in the world Doctors at the center perform 350 transplants a year.

Thomas, born on March 15, 1920, in Mart, Texas, received his medical degree from Harvard Medical School in 1946. In 1963, Thomas organized and became the first head of the University of Washington School of Medicine's Division of Oncology. He was director of oncology for the Hutchinson Center from 1974 to 1989. He is married with three children.

Murray, born on April 1, 1919, in Milford, Massachusetts, also earned his medical degree at Harvard University. He trained as a plastic surgeon and became interested in transplants during World War Two, when he grafted skin onto wounded soldiers. Murray is currently professor of surgery emeritus at Harvard Medical School. He is married with six children.

*Acknowledgement.* Jim Fuller, USIS

# Science News

## A Galaxy Discovered

A team of astronomers from Durham University in north-east England has discovered a new galaxy which is said to lie half way to the edge of the universe, says a British Science and Technology news report. Professor Richard Ellis, Dr. Jeremy Allington-Smith and Mr. Ian Small were able to look much farther into space by using the Anglo-Dutch William Herschel telescope in the Canary Islands, in combination with a gigantic natural "magnifying glass".

The three men, knowing that light rays are bent by massive objects, have been using relatively nearby clusters of galaxies as natural cosmic lenses to examine the detailed properties of very remote galaxies which cannot be seen any other way.

Prof. Ellis said "these clusters are akin to magnifying glasses lying in space. Once we know they are there, we use the Herschel in combination with them to see much farther in space than would otherwise be possible."

The new galaxy was discovered during an investigation of distorted images that were seen as two faint arc-like features in the direction of a galaxy cluster known as Abel 963. The Durham astronomers showed that the mysterious arcs in fact represented light from a previously unknown galaxy much farther away than Abel 963, which was acting as cosmic lens magnifying and distorting the light of the background galaxy.

By using its gravitational force, Abel 963 acted like a lens to focus light from the new galaxy into the Herschel telescope. This created a "gravitational telescope" 2,000 million light years long, through which the astronomers were able to see what they described as a spiral galaxy half way back to the origin of the universe.

Distant galaxies such as this, seen as they were when the universe was young, are regarded as important clues to unlocking the mystery of how the universe was created. If more natural lenses like this can be discovered, they can be used as gravitational telescopes systematically to study the history of the universe.

Bending light by gravity and the existence of gravitational lenses were predicted by Albert Einstein, but their practical use in conjunction with large astronomical telescopes is new. The 4.2 metre Herschel telescope is world's third largest optical telescope.

## Villagers Suffer from Intestinal Diseases

Up to 60% of the rural population of India suffers from various intestinal diseases caused by work infestations and protozoal infections, a leading gastro-enterologist has said.

Addressing the 31st national annual conference of the Indian Society of Gastro-enterology, Prof. B.N. Tandon said infestations with roundworm, hookworm and strongloides and infections with *Amoeba historytica* and *Giardia* were most common among rural people.

He said worm infestations led to various gastro-intestinal problems like pain in the abdomen, diarrhoea, dysentery besides protein caloric malnutrition and deficiencies of vitamins, minerals and trace elements.

The protein calorie deficiencies in turn could promote these infections creating a vicious cycle. Hookworm led to anaemia and hypoproteinmia and amoebiasis could cause liver abscess complication.

Under the circumstances the need for proper sanitation, provision for safe drinking water, frequent administration of deworming agents and good nutrition for the prevention of these diseases are to be assured.

## Spinal Tuberculosis Can be Cured by Medicine

Spinal tuberculosis can be cured within six to nine months by chemotherapy alone, it has been established in a study at the Tuberculosis Research Centre in Madras. About 300 patients suffering from spinal tuberculosis were involved in the study carried out at six Government hospitals in Madras.

This finding has immense implications for the management of spinal tuberculosis, the commonest form of extra-pulmonary tuberculosis, said the TRC director, Dr. R. Prabhakar.

Until recently patients of spinal tuberculosis were put on traction, subjected to risky surgery and hospitalized for up to 2 years. Being highly specialized this surgery can be done only in very few orthopaedic centres in India.

The 10-year Indo-British Joint Study at TRC has now concluded that surgery is unnecessary to treat tuberculosis affecting the spine below the neck.

The study found that a combination of potent drugs used to treat tuberculosis of the lung can also cure spinal tuberculosis. Patients can also be treated at home or in a general hospital, rather than a specialized orthopaedic centre.

Chemotherapy eliminates the risk of surgery. Patients can go back to work early, because no hospitalization is necessary. The pressure on the family is also reduced.

## Sun-tanning is a Cancer Hazard

Advertisements using bronzed models should be required to carry health warnings that sun-tanning can cause skin cancer, medical specialists said. The advertising, fashion and marketing industries are irresponsibly promoting tans, counteracting efforts to encourage Australians to reduce their skin cancer risk, the Australian College of Dermatologists said.

"Much magazine advertising still uses tanned models which perpetuates the myth that a suntan is a fashion item, healthy and attractive. This is the message that thousands of men and women, teenagers and children get everyday, every time they open a magazine. I believe that each of these pictures should in fact carry a warning, similar to those found on cigarette packets: sun-tanning is a cancer hazard," said the honorary secretary of Dr. Alan Cooper College.

Mr. Cooper called for a concerted effort to promote the image that "the pale Australian is in, and the bronzed Aussie is out. It is hoped that the tan will no longer be the accessory that 1,000 people each year wear for their funeral."

The Australian industry was lagging behind overseas trends as it is difficult for tanned models to get work in Europe. Most Australian models who develop tans could expect to develop skin cancer, and that many would suffer "significant, noticeable, ugly changes" to their skin as early as their late 20s.

Mr. Cooper also criticized parents who do not protect their children from the sun. "When I see parents with very young babies on beaches with no protection, I think that is child abuse," he said.

# Unlocking the Hidden Energy in Plants

Lignin, which livestock can't digest, gives plants their structure and rigidity. It's the substance that cements cellulose and hemicellulose in and around plant cells like mortar and concrete hold bricks in a wall.

Because it ties up the energy in cellulose and hemicellulose, lignin is the most limiting factor in forage digestibility.

Forages supply more than 60 per cent of all energy consumed by dairy cattle; for beef cattle, it's 80 per cent, so making forages more profitable is a key part of the research of many agricultural scientists.

Many solutions to the problem of breaking lignin's bonds have been suggested. These range from traditional plant breeding and dowsing plants with a common household antiseptic and bleach to hitting crops with laser beams.

In the mid-80s, an American chemist at the Northern Regional Research Center in Peoria, Illinois, began treating crop residues such as hay and corn stalks with hydrogen peroxide—a common household antiseptic and bleach. The effect was greater digestibility due to degradation of lignin by the bleach. This process has since been refined and adapted for commercial use.

An Agricultural Research Service (ARS) agronomist, James R. Forwood, is currently using high technology to tackle lignin According to him microorganisms in an animal's rumen break down fibre faster if forage has had tiny holes punched in it by laser beams.

"Farmers now use grinding to break forage into more digestible pieces, and that takes a lot of costly energy. If some day, lasers become as common as calculators are today, farmers may consider replacing grinders with lasers," says Forwood.

Previous work by Forwood also showed that spraying plants with cellulose, a natural enzyme that breaks down cellulose in the animal's rumen, increased digestibility of some specific grasses by about 4 per cent.

Scientists at the ARS Russell Research Center in Athens, Georgia, are getting more information about the chemical processes in a plant that result in limited digestibility by way of a new technique using microspectrophotometry.

Microspectrophotometry replaces less accurate analyses of whole plants or plant parts by letting researchers look at individual cell walls and define digestibility.

"The problem with analyzing whole plants is that some parts are digestible, some partially digestible, and some indigestible," says ARS microbiologist Danny E. Akin.

A new area of inquiry involving the study of anaerobic fungi living in the animal's rumen is also being pioneered by the Athens group.

The anaerobic fungi—so named because they live without oxygen—don't actually metabolize lignin; they attack tissues that contain lignin during digestion. The fungi produce enzymes that in turn release phenolic compounds.

If the anaerobic fungi were given an environment in which they could be more competitive with other bacteria living in the rumen, they could better do their job of weakening lignified tissue.

"Someday we may be able to recommend certain grasses or supplements to cattle diets that would encourage the growth of these fungi in the rumen," says Akin. He is looking for fungal species of this kind in other countries that are more active than those found in U.S. cattle.

Besides plant genetics, fungi that cause wood to decay is another area of research. Some of these fungi selectively remove lignin, leaving behind a residue that is more digestible by rumen bacteria

Courtesy: *Science Update*

## New Human Herpesvirus Discovered

A new human herpesvirus has been discovered by scientists at the National Institute of Allergy and Infectious Diseases in the United States. Designated HHV-7, or human herpesvirus 7, it is the seventh herpesvirus now known to infect humans. The new virus preferentially infects T cells, a type of immune system cell.

Investigations are underway to determine whether HHV-7 may be linked to any human disease. The six other known human herpesviruses—herpes simplex viruses 1 and 2, varicella zoster virus, Epstein-Barr virus, human cytomegalovirus, and HHV-6—cause a spectrum of mild to severe illness in humans, including cold sores, chickenpox, shingles, mononucleosis, and genital herpes. In rare cases, some herpesviruses can cause life-threatening encephalitis, or if transmitted to a fetus, congenital malformations. Immunosuppressed individuals can suffer unusually severe disease.

The discovery came to light when Dr. Niza Frenkel, head of the infectious diseases unit of the Institute's Laboratory of Viral Diseases, and her colleagues examined a sample of T cells given to them by Dr. Carl June of the Naval Medical Research Institute in Bethesda He was studying these cells because they carried CD-4 markers, which the AIDS virus uses as receptors to enter T cells. The cells had been exposed to conditions that activate them, inducing them to divide.

During activation, some of the cells changed their appearance—they ballooned in size and formed small clumps of cells known as syncytia It was clear that the cell culture harboured some infectious agent, and Frenkel and her colleagues decided to try to ferret it out and characterize it.

After isolating the infectious agent and examining it under an electron microscope, they saw clearly that it belonged to the herpesvirus family. They suspected that the virus was HHV-6, since that was the only human herpesvirus known at the time to infect T cells preferentially. Yet once they had successfully grown the virus and characterized it genetically, they found that this new virus was distinct from HHV-6, and they named it human herpesvirus 7. HHV-7's genetic makeup shows that it most closely resembles HHV-6 and human cytomegalovirus.

Viruses of the herpesvirus family, which includes the human herpesviruses, infect more than 80 different animal species. Like the other human herpesviruses, HHV-7 has a 20-sided protein-shell containing a large DNA core. The shell itself is enveloped by a membrane.

Human herpesviruses also share the property of latency—that is, the viruses remain in the body for life, though they can switch between active and dormant states. The classic example of herpesvirus latency is herpes simplex virus 1, which causes cold sores during its active phase but retreats to neuronal cells during dormancy. Upon exposure to strong sunlight, or when a person suffers from high fever, the virus becomes active, causing a recurrent cold sore or fever blister.

It was in 1986 that scientists announced the discovery of HHV-6. At that time, it was 20 years since a new human herpesvirus had been found. As scientists continue to perfect techniques for growing different cells and manipulating their function in the laboratory, Frenkel says she expects more human viruses will be uncovered. "And herpesviruses would be prime candidates for new viruses," she comments, "because they can sit there very quietly, not doing anything, until you start to change the host cell."

Courtesy: *Science Update*

## Guinea Worm Eradication in India

Guinea worm maims and cripples at least 10 million people each year in India, Pakistan, and

Africa. Worldwide more than 100 million people are estimated to be at risk of the infection. The donated larvicide, worth about $2 million, is for a five-year eradication campaign to begin shortly in India and Pakistan, in addition to 18 African countries.

Guinea worm is a problem in many areas of India where tanks, *baolis* and other stagnant water bodies are used for drinking water supply. The immature guinea worm, ingested through contaminated drinking water, develops a year later into a worm measuring up to a meter in length It causes extreme pain and disability Any part of the body can be infected. The larvicide, Abate, destroys the larvae of guinea worm in the water but leaves the water suitable for drinking.

The American Cyanamid Company has donated a large amount of larvicide for a programme aimed at eradicating guinea worm worldwide by the year 1995.

Former President Jimmy Carter, accepting Cyanamid's donation on behalf of the Atlanta-based Carter Center's Global 2000 Guinea Worm Eradication Programme, said the gift "will be instrumental in ending the unnecessary suffering of millions of people."